

**DOUBLE-BONUS ISSUE:** ■ 90-page Car Repair Manual ■ 10 home-shop plans

MAY 1980 \$1.25

# Popular Mechanics

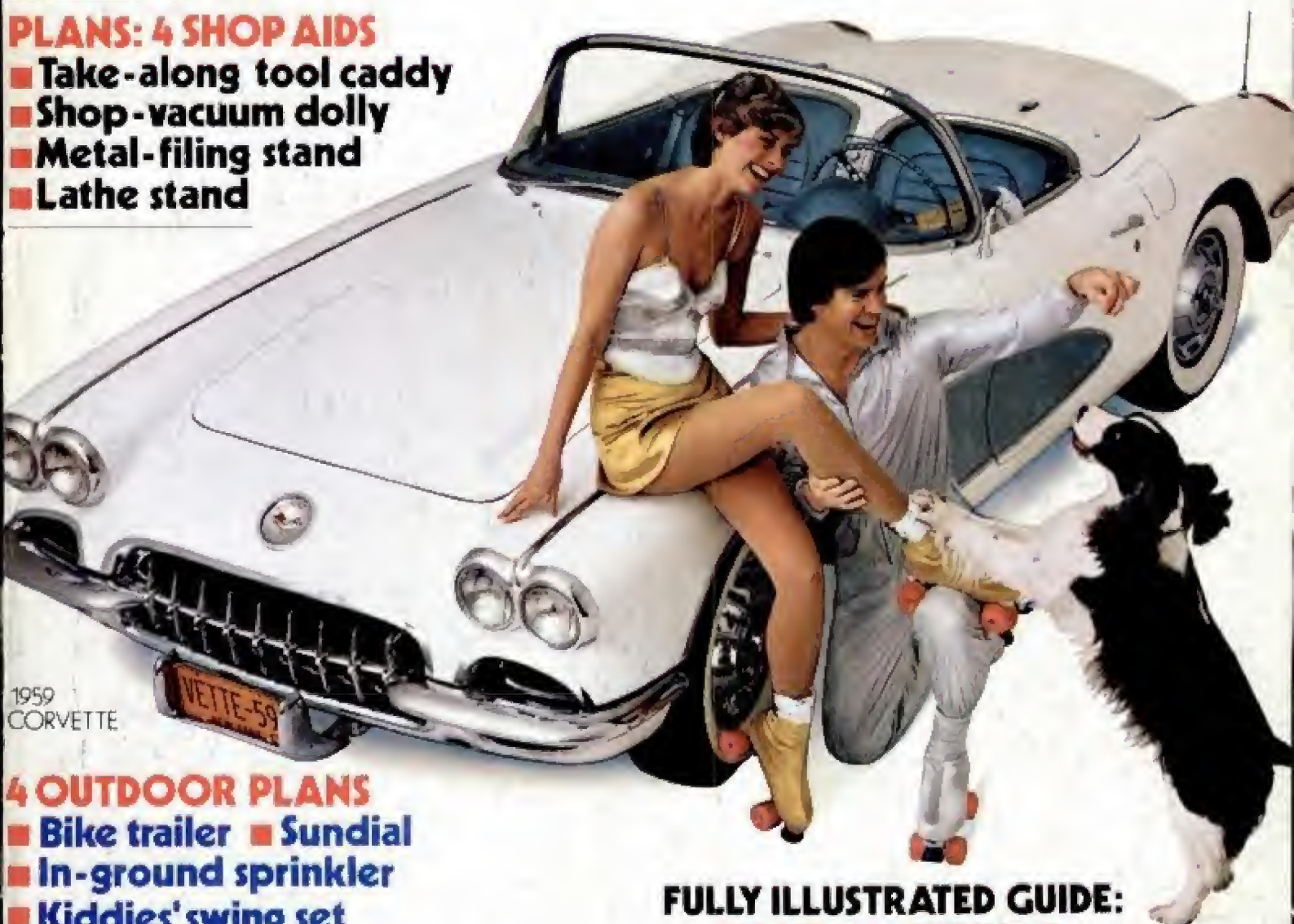
**Secrets of Porsche's revolutionary new Indy 500 challenger**

**PLANS: 4 SHOP AIDS**

- Take-along tool caddy
- Shop-vacuum dolly
- Metal-filing stand
- Lathe stand



**WOODWORKING:**  
2 heirloom cradles  
you can build



1959  
CORVETTE

**4 OUTDOOR PLANS**

- Bike trailer ■ Sundial
- In-ground sprinkler
- Kiddies' swing set

**WORLD'S WORST OIL SPILL:** How it happened

**How to soundproof your home**

**FULLY ILLUSTRATED GUIDE:**  
**THE 50 STEPS**  
**THAT KEEP YOUR CAR**  
**RUNNING LIKE NEW**  
**FOR YEARS AND YEARS**







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**Roomy interior** has all-new styling, options like tilt steering wheel, reclining Captain's Chairs up front, AM/FM stereo with cassette or 8-track tape player.



**New Bronco choices** include six roof colors. Above: Landau Tu-Tone with accent tape stripe. At top: Free Wheeling Bronco shown with optional tri-color tape stripe, styled steel wheels, RWL tires, and more.



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## On the cover

The classic lines of a well-kept 1959 Chevy Corvette blend right into a 1980 skating party. PM's annual Car Care Guide, beginning on page 139, can keep your wheels turning with a complete 50-step program.

—PM photo by Jerry Abramowitz

# Popular Mechanics®

May 1980

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# Until now, it wasn't just the birds that came back each spring.

Ever notice how the concrete cracks you repair one spring come back the next?

That's because most concrete repair products can't handle the expansion and contraction brought on by seasonal temperature changes. (Not to mention the constant exposure to day-to-day weather changes.)

But new DOW CORNING® Silicone Concrete Crack Sealant is different. It's 100 percent silicone rubber. So it forms a flexible, waterproof seal that won't crack, crumble or shrink as the seasons do their annual thing.

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# LETTERS TO THE EDITOR

## What admiration?

While the moped story in the March issue (*What You Should Know Before You Start Commuting by Moped*, page 102) contained much valuable information, I disagree with the statement that "moped commuters seem to elicit a certain amount of admiration from other motorists."

In two years of moped riding, I have discovered otherwise. Too many drivers go out of their way to make it unpleasant and unsatisfactory. Drivers deliberately try to sideswipe me, fail to yield the right-of-way, needlessly honk at me and make obscene gestures. In short, they show no respect. Occasionally, one will wave or give me passing room, but not often.

NAME WITHHELD UPON REQUEST  
FORT WAYNE, IND.

## All dolled up

I want to share the pleasure of completing a project inspired by one of your articles (*Two Enchanting Doll-*

*houses You Can Build*, page 116, Dec. '76). Working time was about a year. Some of its features include: hand-cut redwood shingles, stained



Reader Marnatti's hand-crafted dollhouse.

glass windows, timer-operated lights, a bay window with working bench seats, Tiffany lamp made from half a Ping-Pong ball and flooring made from 1/4-inch veneer strips. Thanks for looking.

CARL MARNATTI, M.D.  
PITTSBURGH, PA.

*Nice work, Dr. Marnatti. Plans for the dollhouses are still available to PM readers for \$7.95, from the Popular Mechanics Plans Library, Dept. TS, Box 1014, New York, N.Y. 10019.*

## Praise for balloonists

God bless the Wetzels and Strelzyks (*The Freedom Balloon*, page 100, Feb. '80). Their story of ingenuity and determination is like a fresh breeze. The illustration of the East German border installations (page 103), however, is a sad picture to behold.

CHARLIE WEAVER  
WINSTON-SALEM, N.C.

KING: 16 mg. "tar", 1.1 mg. nicotine, 100's: 20 mg. "tar", 1.4 mg. nicotine, av. per cigarette, FTC Report DEC. '79.

Warning: The Surgeon General Has Determined  
That Cigarette Smoking Is Dangerous to Your Health.



Light mountain breezes.  
Clear, rippling waters. And  
country fresh Salem menthol.  
That's satisfaction.



### Antenna antics

In "An Easy Way to Make a Short-wave Antenna" (*PM Electronics Monitor*, page 84, Mar. '80) there is a serious omission. There should be a lightning arrester between the outdoor antenna and the radio.

DAVID J. NOVELLI  
MEMPHIS, TENN.

*We agree that a lightning arrester is a good idea for use with any antenna system. Alternatively, the antenna may be grounded when it's not in use.*

Just a bit of constructive criticism: The coax cable is shown unprotected, and it will soon act as a hose, with rain and moisture appearing at the back of the radio. Rain will follow the foam or other dielectric along the shield and into the house. I would suggest a center insulator with a type SO-238 fitting, with a PL-238 fitting on the coax to help maintain the impedance of the line. This should be well-wrapped with good plastic tape and, if possible, sprayed with waterproof spray. Hope I have been helpful.

EDWARD MC QUILLEN  
MANCHESTER, N.H.

*A good suggestion. There are also some silicone-based waterproofing materials available in squeeze tubes. Make sure that you use the nonconducting variety.*

### Count him out

"The Census—This One Counts" (*PM Briefs*, page 49, Feb. '80), undoubtedly was spoon-fed to you by the Feds, and is a prime example of why the government has lost most of its credibility. The penalty for an individual for refusing or failure to give information to the census taker is not more than \$100. (Title 13, U.S. Code Census, Chapter 7, Subchapter II, Par. 221). It's \$1000 for giving false information (Chap. 7, Subchapter II, Par. 222).

As for confidentiality, baloney. It would be impossible for me to know where the information I provide really goes.

E.E. LEIBERT  
WALLA WALLA, WASH.

*Reader Leibert knows his census code: A \$5000 fine is only applicable when a census employee violates the principle of confidentiality or misuses information. However, none has ever been convicted. It's also true that*

*the individual has no guarantee against misuse beyond the fact that it is a punishable crime, but it still seems to us that private citizens have far more to gain by cooperation with the census than opposition—unless, of course, you really have something to hide.*

### Sensitive

The article in the February issue dealing with sensors in the automobile (*How to Find, Service and Replace Your Car's Sensors*, page 35) was both very interesting and informative.

I'd like to clarify testing of the oxygen sensors used in the General Motors C-4 system or the Closed Loop Carburetor Control. We tell service people not to connect any test instruments to the oxygen-sensor terminals. Connecting a low-impedance analog voltmeter to the sensor will damage it. Our published diagnostic procedures, aided by diagnostics built into the system, permit us to determine the sensor function without connecting test instruments.

JAMES M. IRWIN  
GM SERVICE RESEARCH  
WARREN, MICH.

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country fresh  
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**4. NACA foil lower unit.**

Our research at the University of Berlin water tunnel has produced a modified NACA foil shape for Chrysler lower units. Saves fuel. And it's faster.

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# PM ELECTRONICS MONITOR

## Legalize CB outlaws?

Earlier this year, the Federal Communications Commission indicated that it may well legalize exclusive single-sideband (SSB) frequencies for citizens band communications. These new frequencies would go from 27.41 to 27.54 Mhz, or channels 41-53 (the band presently ends at channel 40).

But many sidebanders are *already* on those frequencies, operating illegally, and they've been there for years. Because of the sophistication of SSB gear, many who operate in this mode have tried to move away from the incessant chatter and nonsense on many CB channels. Like radio vigilantes, they have taken the law into their own hands.

These outlaw SSBers have been doing such no-nos as working stations far beyond the legal limit of 150 miles, and adjusting their transmitting frequency with tunable "sliders," rather than simple channelized operations as required by law. And, of course, they've been running power much higher than is legal.

The FCC occasionally "busts" these illegal operations and confiscates the equipment. But the enforcement level has been quite low and the outlaws have had little fear.

Now they can have even less. The FCC is also thinking of legalizing "sliders" and communications beyond the 150-mile limit.

Perhaps this legalization is a good idea. It may rejuvenate the whole CB market.

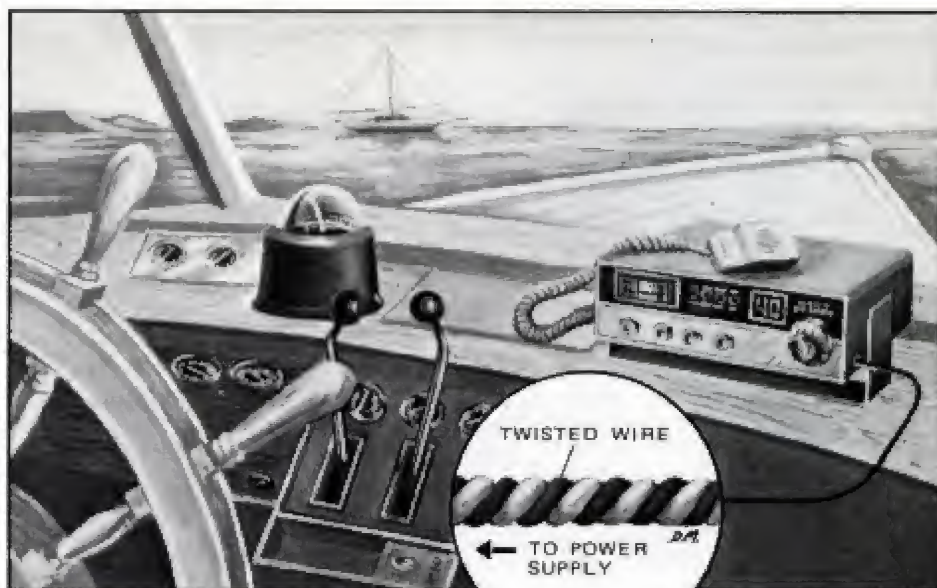
But the question of setting a precedent remains. Is it really wise to simply legislate a problem out of existence?

## Videoconfusion

Everyone in the field expects the new videodisc players to take the world of consumer electronics by storm. Many are saying that it will be the greatest advance in television since color.

But the problem is that present competing and incompatible technologies may cause a wait-and-see attitude among potential buyers. This may turn the takeoff of the videodisc market from a comet-like rush to a snail's crawl.

The original two systems, Magnavox (Philips-MCA) and RCA, were very different. Magnavox used a laser and RCA a capacitance-pickup stylus.



## Keep your compass pointing true

Every boating season there are certain to be skippers who wind up cussing their compass for its inaccuracy. But the fault really may lie not with that instrument, but rather with a piece of electrical equipment that is located near the compass.

When you run power leads to your boat's 12-volt battery, you should be certain to twist the

two wires together. This is not just for the sake of neatness, either.

Untwisted wires can set up a magnetic field caused by the flow of opposite charges down each of the two power leads. This, in turn, can affect a compass in the same manner as if someone were holding a magnet nearby—the needle will no longer point true north.

Now Matsushita (Panasonic) has further muddled the videodisc waters with an announcement that it, through its subsidiary, Japan Victor Corp. (JVC), has developed yet a third method. The new system uses a capacitance-pickup, but the disc is not grooved, as is RCA's.

Matsushita announced further that it and JVC hope to market to secondary manufacturers. It also blue-skyed the notion that this system may become the standard one in Japan.

A standard is certainly needed, here as well as in Japan. However, should the consumer be asked to guess the winner when he puts \$500 to \$800 of hard-earned cash on the counter?

Competition in the marketplace is fine to a point. But as standardization must come sooner or later, perhaps the manufacturers should get together to make it sooner. It could only help them by creating a greater market for a videodisc machine that the consumer was certain would not be quickly outmoded.

## Ultimate personal computer?

The new personal computers have been filtering increasingly into business offices as software becomes

more available. Now, small computers can be expanded to truly gargantuan proportions, thanks to something called the Clustershared Microcomputer System from Nestar Systems.

Up to 64 of the popular Apple-brand personal computers can be combined into a single multi-user system.

This means everyone in the office has instant access to all data, such as inventory, billing and the like. With 8-inch floppy discs, a full system can have over 30 megabytes storage—a most impressive figure.

If you're thinking of computerizing a large office, check out Nestar's system. (Nestar Systems Inc., 430 Sherman Ave., Palo Alto, Calif. 94306.)

PM





A dramatic, low-key photograph of a person in a red jacket and hat riding a dark horse. They are positioned in the center-left of the frame, facing right. The horse is dark and its form is mostly in silhouette. The rider's red jacket is a bright, contrasting color. They are riding over a dark, rocky, and uneven terrain. In the background, a thick mist or smoke rises from the ground, partially obscuring the horizon. The sky is filled with heavy, grey clouds. The overall mood is somber and atmospheric.

# ONE CANADIAN STANDS ALONE



CANADIAN WHISKY - A BLEND - 80 PROOF - IMPORTED AND BOTTLED BY THE WINDSOR DISTILLERY COMPANY, NEW YORK, N.Y.

# WINDSOR





# An unfair comparison of the world's two best known woodcutters.



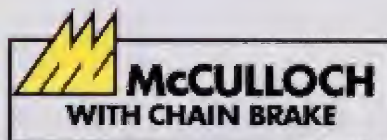
## The beaver

Sharpens its own teeth.  
Easy to start.  
Never needs oiling.  
Stops when tired.  
Hard working and reliable.  
Padded paws and thick fur  
for smooth operation.  
Comes completely  
assembled.  
Not available at any price.  
Hard to find.  
A good swimmer.

## The PM 320

Sharpens its own teeth. (Auto-Sharp™)  
Easy to start. (Electronic Ignition)  
Oils itself. (Automatic plus manual oiling)  
Stops in milliseconds. (Chain Brake/Hand Guard)  
Hard working and reliable.  
Anti-vibration system for smooth  
operation.  
Comes completely assembled with a  
carrying case worth \$24.95\*  
\$189.95 manufacturer's suggested list price.  
Easy to find in the Yellow Pages under "Saws."  
Cannot swim.

\*Offer expires June 30, 1980.



**Sawing is believing.**



# DETROIT LISTENING POST

## Ford five-speeds and turbos

Ford deserves a standing ovation for making a new, optional five-speed manual transmission available in its 2.3-liter turbo Mustangs and Capris, beginning about the time you read this. The U.S. industry has dragged its feet on fun, fuel-saving five-speeds with overdrive, while the Japanese have run away with the five-speed market in affordable small cars. Manual-shift fans should hope the new transmission (a modified four-speed) is better than the awful GM five-speed that was finally cancelled this year for lack of buyer interest. Ford also plans some larger 2.5- and 3.0-liter turbocharged engines for its 1983 Mustang/Capri in hopes of earning back some of that long-lost youth and performance image. Bravo!

## Concept cars

In spite of Detroit's tight money situation a handful of interesting con-



The concept cars from top to bottom are: Chevrolet's turbine-powered Astro III, Chrysler's Magnum and, from Ford, the wedge-shaped Navarre and Lucano.

cept cars will be making the rounds of the auto-show circuit this spring.

Ford has two such concept cars on the circuit, both designed by the Ghia studios. The Lucano is a two-seat sports car, based on the European Escort, which resembles the TR-7 in its wedged lines. The front-mounted engine could range anywhere from 1.1 to 2.0 liters. The Navarre is based on the U.S. Granada and is a five-seat sport coupe fitted with a 5.0-liter V8. It features a flat rear deck with tie-down straps which could carry extra luggage.

Chrysler is showing a customized version of its Mirada and carries the familiar Magnum name. The mechanicals are identical to the production Mirada and the only changes made were in the skin.

Chevrolet has produced a radical design in the form of a three-wheeled, turbine-powered car called Astro III. It incorporates a power canopy which lifts forward and up and a closed-circuit television screen which substitutes for conventional rear-view mirrors.

## You heard it here

We predicted back in March that all the American car manufacturers were toying with the idea of producing micro commuter/shopper vehicles. Our prediction proved correct and it seems as if General Motors will be first in the market.

The proposed car is a two-seater with a 90-inch wheelbase fitted with the X-car-based 2.5-liter, four-cylinder engine and transaxle. The engine will be mounted transversely ahead of the rear wheels. In this configuration it should provide a powerful combination of excellent performance and fuel economy.

Pontiac Div. will be in charge of design and development and if it goes into production it will be the first ever mid-engine American-built car.

Models will be available in both hatchback and notchback versions. An optional 2.8-liter turbocharged V6 engine will also be available. If all goes well in the planning stages, the vehicles could make their first appearance in as little as three years.

In the future, we'll probably be seeing a lot more of this engine and transmission swapping, not only in

GM cars, but throughout the industry. It seems that modularity—plugging existing components into various vehicles built for specific applications—will be the wave of the future.

## GM intermediate preview

Our spy camera caught a glimpse of what the 1981 GM A-Special luxury intermediate will look like.

The new body treatment shows a lower nose, higher deck lid and altered roofline. These changes have all been made in the interest of better aerodynamics. Below the skin, pounds and ounces of excess weight have been removed, which means gains of several mpg.

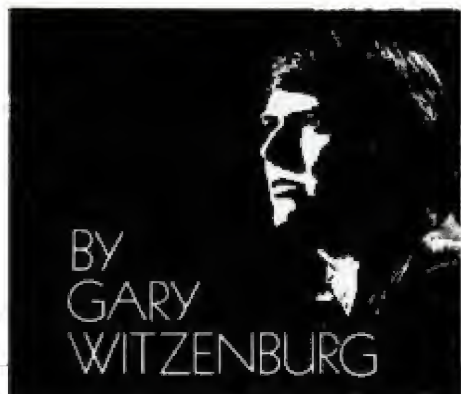


GM's 1981 A-bodies feature a sloped nose.

The rest of the A-body line (Malibu, LeMans, Cutlass and Century) will remain unchanged for 1981. These models will probably remain frozen until 1982, when they will all be transformed to front-wheel drive.

## 1983 AMC/Renault

The new front-drive car that Renault will design and AMC will produce (in Kenosha, Wis.) for '83-model introduction will be sized and priced between the current Renault Le Car mini and the R-18 compact. It will offer exceptional economy for its size from a choice of gasoline or turbocharged diesel four-cylinder engines. All of its engines and transmissions will be French-built. The car will very likely replace AMC's current Spirit subcompact. **PM**







## Volkswagen's new Pickup: It's built like

Where is it written that a truck has to drive like a truck? Certainly not on that brand new Volkswagen Pickup Truck.

When it comes to going, a VW Pickup can pick 'em up and lay 'em down with the best of 'em. Under its aerodynamic hood is a very dynamic engine. A fuel-injected, over-

head cam powerhouse that can outaccelerate even an MGB.

And should you ever catch up to a VW Pickup, you'll never catch it wallowing through corners like other trucks. Its front-wheel drive and front-mounted transverse engine help keep it





## a truck, but drives like something else.

moving nimbly. Even when the road throws it a curve. The steering is precise and quick because it's Volkswagen's rack-and-pinion system.

What's equally impressive is how good a pickup a VW Pickup is. It's the only truck in its class with a fully unitized body and double-wall

bed construction for extra strength. And its heavy-duty suspension takes the tension out of hauling over 1100 pounds of stuff. So a truck is a truck is a truck, eh? Well, not if it's a Volkswagen

Pickup Truck. Then it's something else.

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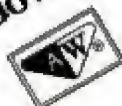
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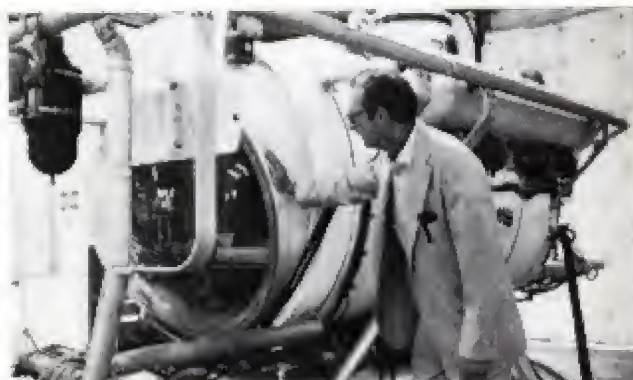


## NOTES FROM THE EDITOR

*John A. Sillitto*

June 3 will mark the first anniversary of the blowout of oil well Ixtoc 1 in the Gulf of Mexico. It appears that oil will still be oozing into the Gulf when June rolls around again. Some petroleum specialists consider the unprecedented spill to be the "Three Mile Island" of the offshore-oil industry.

We assigned former PM Science Editor John Pearson (now a free-lancer based in Florida) to take a look at the blowout and report on how it all started and what is being done about it. After flying over the site, interviewing dozens of people and walking on the



Pearson with Martech International's three-man sub—ready but not needed as remote-control TV pinpointed oil leak.

beaches of South Padre Island, John turned in the story on page 106.

He reported a certain learn-to-live-with-it attitude among Gulf coast Texans, one of whom, a luncheonette owner, touts a menu featuring "oil-slick soup"—a blend of chicken broth, "seaweed" (broccoli) and "culinary crude" (soy sauce). Not quite so sanguine is at least one car-rental agency that threatens a \$100 fine if inspectors find oil tracked onto the floor of a rented car. (John admitted that he had slightly lubricated the floor of his rented car, but so far no one has fined him.)

Along the way, he picked up a nice fuel-saving tip for anyone who commutes in a four-engine plane. The Coast Guard Hercules turbo-prop that took him on a 10-hour flight over the leaking well flew a good part of its mission with two engines shut off—to save fuel.

It's no secret among PM readers that doing it yourself really, truly can save money (even though getting the job done better and faster may rank ahead of money-saving as a motive).

Remember the classic toolbox that appeared on last November's cover? Its fine cherry wood and brass fittings cost about \$250. Beyond that, we supplied complete plans and you supplied labor to build it.

We heard of one reader who wanted to have the toolbox built and got estimates from two expert craftsmen. Both figured it would cost about \$1400 for everything. So if you built it, you can claim you earned \$1150 for your labor. Not bad.

We're back again this year with the eighth annual May Car Care Guide (page 139), a feature we judge from reader mail to be one of the most helpful we publish. And writing it again is Mort Schultz, whose wizardry with car problems is well known to you fans of his monthly Car Clinic. We think Mort has done a topnotch job of organizing a complete car-care schedule into the 50 basic steps that'll keep your car young for years and years.

Back again, too, is Pack Bryan with his history of foreign cars at the Indy 500 (page 99). When Pack takes his seat in the stands on May 25, it'll mark his 29th straight year of Indy attendance—a record that befits a Brickyard historian.

PM



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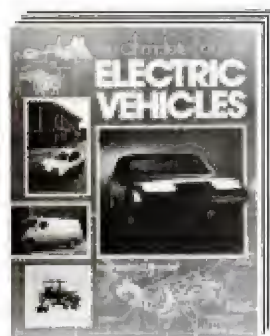
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# APPLIANCE CLINIC

## QUESTIONS ANSWERED

### Rechargeable batteries

*I have a question regarding rechargeable appliances such as tools, razors and lawn equipment. Should they be connected to their chargers when not in use, or only after they have been completely discharged? — Ralph Blodget, Santa Paula, Calif.*

Unless stated otherwise by the manufacturer, rechargeable products that fall into the "tool" category usually are designed so they can be connected to their chargers when not in use without any damage to their batteries. The circuits in the chargers provide a "trickle" charge to the tool after the full charge has been reached. This assures a full surge of power for tools that are used frequently and for long periods of time, without having to wait several hours for a complete recharge.

### Tipsy washing machine

*I have a Kenmore Automatic washer (Model No. 110.550590) that constantly goes off balance. When I reset the dial by pulling it out and pushing it in again, the buzzer doesn't shut off and the spin or rinse cycle won't continue. The only way to restart it is to tilt the machine back and bounce it. The diagram and parts list don't appear to list an off-balance switch. Is this in the timer? — Garry Jaffe, Chicago.*

The model number indicates that your machine is 13 or 14 years old. Because of this, the most likely cause of your problem is excessive (uneven) bearing wear. Test this by rocking the basket to check for looseness, and by running the machine on spin with no load while listening for a loud knocking sound. If neither of these conditions exists, then it's possible that the off-balance switch is faulty.

Long shot: If the machine has been serviced recently, there is the possibility that the transmission braces were inadvertently left off.

### Swinging toaster door

*I have a 5-year-old GE Toaster Oven. It works fine on the BAKE setting, but when I place it on the TOAST setting, the door springs open after 15 seconds. I think the problem is the thermostat. Can I get it replaced or do I have to purchase a new appliance? — David A. Gewirtz, Richmond, Va.*

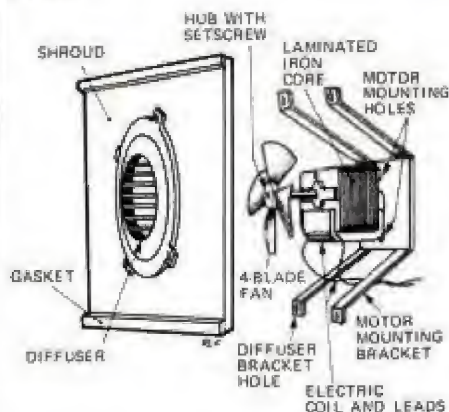
You can repair the oven for about \$13. The problem lies in the solenoid

thermostat, which must either be adjusted or replaced. The adjustment involves recalibrating the TIME and TEMPERATURE screws located on the thermostat. These can number as many as five, depending on the model you have. This calibration is critical and must be done with a thermometer in the oven. Replacing the thermostat is time consuming and requires patience. I suggest you have the oven repaired by a local, authorized service center.

### Singing refrigerator

*My Hotpoint refrigerator/freezer (Model No. 1CSFC618G) has developed an intermittent whistle-chirping noise when the freezer motor operates. When I open either the freezer or refrigerator door, the noise stops. What is wrong and how can I fix it? — Stanley Balick, Baldwin, N.Y.*

The noise is probably coming from the small bearings in the evaporator fan motor. This motor operates only when the doors are closed. It shuts off to prevent cold air from blowing out of the freezer when the doors are open.



Evaporator fan runs when door is closed.

Some light lubrication may help, but the motor eventually will have to be replaced. The part number is WR60X5022; it costs about \$28.

To get at the fan (see drawing, above), remove the entire fan assembly, consisting of a diffuser, shroud, gaskets, brackets, fan and motor. Unplug the refrigerator. Remove the screws at the top rear of the freezer and the screws on the side. Tilt the entire assembly forward and out of the freezer section.

Unplug the fan from the top rear

(Please turn to page 22)





The new Energair ionized oxygen generator will make a handsome addition to any desk.

# Miracle Fuzz

*A new space-age invention and the same effect as lightning combine to create the world's first home oxygen regeneration system.*

You need oxygen to live. You can live without food for 60 days, without water for seven days, but without oxygen, you won't make it past two minutes.

That small piece of fuzz located on top of the cylinder shown above emits negatively-charged electrons which attach themselves to molecules of oxygen, thus creating ionized oxygen.

You are already familiar with ionized oxygen if you've smelled the air after a thunderstorm. You feel great, revitalized, and alert. The lightning from the storm adds a small negatively-charged electron to each oxygen molecule in a process called ionization.

## SCIENTISTS DISCOVER

Scientists discovered that air quality can actually affect your moods, your feelings and your sense of well being. Air that is positively charged caused people to be depressed, moody and tired. Negatively-charged air made people feel good. We have all experienced air that is positively charged in air-conditioned buildings or in a polluted environment.

Scientists looking for a way to turn positively charged air into negatively charged air developed the negative ion generator—a product that produces negatively charged particles that attach themselves to air molecules and thus create the same fresh feeling you get after a thunderstorm.

The new space-age product shown above is an ionized oxygen generator called the Energair air purifier. The copper mesh fuzz on top of the unit is one of the secrets of the system.

Although it has no moving parts, you can actually feel a wind of ionized oxygen produced from the fuzz which spreads to fill an average-sized room in one minute.

## CIGARETTE SMOKE TEST

To show the dramatic effect of ionized oxygen, you can take the Energair, blow cigarette smoke into a clear bowl, and hold the bowl inverted over the system. The smoke will vanish. The charged oxygen particles appear to dissolve the smoke particles, precipitating them from the air.

In a room, the Energair air purifier surrounds you with these oxygen ions and cleans and purifies the air so that even in a smoke-filled room, you will be breathing cleaner, country-fresh air all day long.

## WALL TEST

Take our unit and place it next to a wall. Also

put a large piece of paper on the wall. Within a few days notice how black the paper gets. That black film is fine carbon particulate matter—the same pollutants you would normally breathe and that would pass through most air filters. By placing the unit in the center of a room or away from a wall, that same matter falls to the ground as dust.

A trip into the mountains exposes you to nature's freshly ionized oxygen. The Energair produces this same effect. It will clean your room of odor-causing bacteria and stale, musty, or smoky air.

Ionized oxygen should not be confused with ozone. Ozone has a molecular formula of  $O_3$ , whereas the molecular formula for ionized oxygen is  $O_2$  with a negatively-charged ion.

## DON'T BE CONFUSED

After we announced the Energair last year, many companies came out with their own ion generators. We purchased a unit from each company and tested them at an independent laboratory. The results are shown below:

Name	*Ions	Price
Energair	438,000	\$79.95
Omega 700	63,000	245.00
AirCare	72,000	149.95
Modulon	75,000	79.95

\*Measurements indicate total number of ions per cubic centimeter per second at one meter. These figures may vary by plus or minus 10%.

Note: One unit not mentioned above produced no ions and actually produced ozone or several times the maximum ozone concentration allowed by federal government standards.

## USED IN HOSPITALS

Many hospitals are now using ionized oxygen systems in their operating rooms and burn centers. Their units not only purify the air, but they also eliminate pollen and other irritants.

Working in a clean air environment, you think clearer, are more alert, and you function better. The Energair is actually a miniature lightning machine. The minute you plug it in, energy is converted into ionized oxygen. This efficient system uses one watt of power or less than a penny per day to operate, so you leave it plugged in continuously.

We are so impressed with the pleasant effect of Energair that we urge you to personally test it yourself in your home or office. Order one at no obligation. Put it by your desk, or in any room where you spend a great deal of time. See if it doesn't rid your room of odor-causing bacteria and stale, musty or smoky air. Try the smoke and paper tests mentioned in this advertisement.

## SLEEP FASTER

At home, use the Energair by your bed and see how country-fresh air allows you to sleep easier, deeper, and more relaxed.

You should notice the difference within one day—especially in a work environment. But use the Energair for a full month. Then, if you do not feel totally convinced of the positive effects of ionized oxygen, return your unit for a prompt and courteous refund.

The Energair is manufactured by the Ion Foundation, a leading ion research and development company.

Service should never be required, but if it is, there's a prompt service-by-mail center as close as your mailbox. JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected. The Energair measures 9" high by 3" in diameter and weighs 24 ounces.

To order your Energair ionized oxygen generator, send \$79.95 plus \$3.00 for postage and handling (Illinois residents, please add 5% sales tax) to the address shown below or credit card buyers may call our toll-free number below. We will send your Energair ion generator complete with 90-day limited warranty on the electronics, a five-year warranty on the fuzz, and complete instructions.

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**LINCOLN**  
**ELECTRIC**

## APPLIANCE CLINIC

(Continued from page 20)

of the freezer liner. Remove the two screws holding the diffuser plate and then the two remaining screws holding the motor mounting bracket. Carefully remove the mounting bracket from the motor. Note the motor position and grommet location. Remove the hex setscrew securing the fan blade to the motor shaft. Note that the end of the motor shaft should be  $\frac{1}{4}$ -in. from the fan hub. Replace the motor and plug in the refrigerator.

When you reassemble the fan, be careful not to bend the fan blades. Also be sure that all gaskets are back in place and all parts are properly aligned.

### Freezer Ice-up

*I have a new Kelvinator, side-by-side refrigerator (Model No. KMK220-MNID). Moisture is condensing and forming ice inside my freezer door. I never had this problem with my previous refrigerator. Is this normal or is something wrong?—F.W. Haylett, Royal Oak, Mich.*

It sounds as if either the freezer door isn't sealing properly or the economy/moisture switch inside the freezer is off.

If the refrigerator doors were removed during delivery, they probably aren't sealing properly. To test the door gaskets, open the doors and place a piece of notebook paper between the door gasket and box frame. Close the door on the paper. There should be a slight "tug" on the paper as you try to pull it out. If not, adjust the doors by loosening the top hinge screws on the cabinet box and pushing the doors closer to the box frame. Tighten the screws and retest the gasket with the paper. If the door gasket is damaged or deformed, replace it.

The second item to check is a switch inside the freezer wall. It's called many things, among them "economy/moisture switch" and "power miser." It's designed to control a heater behind the door frame where the doors close. This heater prevents condensation and ice buildup.

Consult your owner's manual to make sure the switch is turned to the position in which the heater is on.

PM

If you have a question about any appliance, send it to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.



# Extended Lifespan

*JS&A was destined for failure when we introduced our first electronic blood pressure unit. But then a miracle happened.*

Model 310



Model 410



Advertisements were starting to appear everywhere. JS&A had just introduced the world's first home electronic blood pressure unit in a massive national advertising campaign.

But something was strange. JS&A often tests its products in its catalog first before they are nationally advertised. If they sell well, we then start a national magazine advertising campaign. The blood pressure unit sold well in our catalog, but for some strange reason, it wasn't selling well in magazines.

## SHOCKING DISCOVERY

And then we found the answer. A few months earlier after our blood pressure unit appeared in our catalog, our computer manager (let us call him Ralph to protect his identity) handed us a computer printout of the catalog sales results.

Scanning the results, we discovered that the blood pressure unit was the best-selling product in our catalog—far exceeding every other product by five times.

The results were so positive that we immediately placed hundreds of thousands of dollars in an advertising campaign launched in early 1978.

Just as the advertisements were starting to appear, Ralph walked into our president's office with some startling news. "There's been a mistake," Ralph said. "The computer printout was wrong. The blood pressure unit is actually our worst selling product but a computer error gave us the wrong information."

And so our president sat back and watched JS&A advertisements appearing everywhere, knowing full well that the campaign would cost his company almost the price of a new computer.

Then came the miracle. As if by plan, the American Medical Association came out with

an advertising campaign urging consumers to take their blood pressure regularly to combat hypertension or high blood pressure. Ads appeared everywhere.

The campaign revealed that there may be as many as 25 million Americans who have high blood pressure and don't know it. Simply by taking their own blood pressure and discovering hypertension early enough, Americans could be saving their lives and reducing the chances of heart attacks. Suddenly our campaign started to sell blood pressure units by the thousands.

## AWARD RECEIVED

This year JS&A's president received the Extended Lifespan award for "pioneering in the distribution of home health electronic devices" by the Committee for an Extended Lifespan. In accepting the award, our president made it very clear that the award was earned as a result of a computer error and not as a result of his brilliance.

This story is painfully true. And although it may be a slight embarrassment to us, there is one aspect that is not. JS&A was indeed the company that pioneered the electronic blood pressure units and has always selected the very best units available to offer at the very lowest prices possible.

## NEWEST UNIT

Our newest unit shown above is another example. The model 310 sells for only \$69.95 plus \$2.50 for postage and handling (Illinois residents, please add 6% sales tax.) You simply wrap the velcro cuff around your arm (you can even keep your shirt on) and inflate the cuff. Both an audible tone and a visible red light will indicate your systolic and diastolic readings. The system is extremely accurate, comes with a self-bleeding air valve and can be stored in a convenient carrying case that

comes with each unit.

The deluxe model 410 functions similar to the first system except that the readings are displayed in digits, and the unit also displays your pulse reading. It sells for \$139.95 plus \$2.50 per unit for postage, insurance and handling. If for any reason you are not completely satisfied with either unit, you may return it within 30 days for a prompt and courteous refund including your \$2.50 postage and handling. To order either unit, credit card buyers may call our toll-free number, or you may send your check or money order to the address below.

Both units use solid-state components, come complete with instructions and a one-year limited warranty, and should give you years of trouble-free service. If service should be required, we maintain a service-by-mail center as close as your mailbox. JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected.

If you are concerned about your blood pressure or know somebody who is concerned about monitoring his or hers, we recommend JS&A's latest units.

Incidentally, Ralph left JS&A on his own accord and bought a farm in another state. There were no hard feelings when he left. How could there be? Order your blood pressure unit at no obligation, today.

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SIZE	PRICE	QUANTITY	TOTAL PRICE
4 oz.	\$ 3.25		
8 oz.	4.95		
16 oz.	7.95		
32 oz.	12.95		
1 U.S. Gallon	40.00		

Amount \_\_\_\_\_  
Appropriate  
Sales Tax \_\_\_\_\_  
Handling \$1.50  
Total  
Remittance \_\_\_\_\_



# PM LOOKS AT SUPER LOG SPLITTER



Set the wedge into the log center with a few light taps to keep it in position without its having to be held by someone.



By sixth strike, wedge is flush with log top and splits have reached bottom.



After the seventh strike on the wedge, the green oak log is completely split and wedge has fallen safely to the ground.



Four ax-like tapers meet in a point.

**W**oodox wood-splitting wedge can quarter a log in one safe operation. Aided by several maul or sledgehammer blows, the pointed tool is designed to split logs up to 2 ft. long and 18 in. in diameter.

The maker says the wedge works best on slightly aged logs, but we used it to split freshly cut red oak. The results were good.

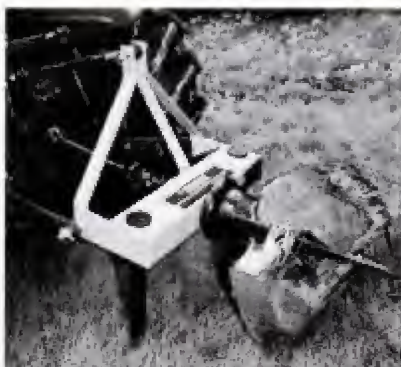
Woodox plans to distribute the wedge nationally this fall. Presently, order it by mail from Woodox, 105 North Hanover St., Pottstown, Pa. 19464. It's \$34.45 postpaid.—Rosario Capotosto

# The Stickler™ Splits logs in seconds.

Knotty, gnarled, green or dry, "The Stickler" power-splits problem wood with ease. It splits circles around many hydraulic splitters yet at a fraction of the cost. Safe, economical and energy efficient, the Stickler is a valuable tool for any outdoorsman.



The Stickler is also a log splitter that's designed like a giant woodscrew, and bolts to the hub of a car or truck. Every Stickler comes complete with a Mounting Plate and a Safety Switch Kit.



The tractor mounted Stickler is a professional tool which will quickly pay for itself. It mounts on a three point hitch and is driven by the P.T.O.

## Distributors and Dealers Wanted

Contact:

Arnold Industries, Box 2790, Toledo, Ohio 43606

Telephone (419) 244-5836



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Wait'll you see how tough they are. Flecto finishes can take a lot more wear and tear than ordinary paint.

And last longer too.

Flecto finishes go on easily.

Level themselves and dry quickly to a smooth, beautiful finish.

You'll find a Flecto finish for just about everything that needs painting. From furniture to fences. Baby cribs to barbecues.

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Right down the line.



When you want to do it right.

This tough, beautiful coating brings out the natural beauty of the wood. And outlasts varnish 2 to 1. Use our VARATHANE Exterior finish with Ultra Violet Absorber to help keep the sun from damaging wood.



**VARATHANE® CLEAR LIQUID PLASTIC.**

It fills, stains and seals all in one application. And that's only half the beauty of it. It gives bare wood deep, rich color and has twice the coverage of ordinary stains. Top it off with VARATHANE Clear Liquid Plastic for the finishing touch.



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Give metal surfaces a longer life with bright, rust-proof colors. And you don't need a primer on ferrous metals, either. It's built right in.



**FERROTHANE® PLASTIC FINISH WITH RUSTAID®**

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**VARATHANE® COLORS IN PLASTIC.**



An unfair comparison  
between  
the Jeep® and Kubota.





The Jeep® vehicle. Part car. Part truck. And, best of all, part mountain goat. You might even say it's become a way of life.

So how can we compare a Kubota to a Jeep vehicle? A tractor to an institution? Easy. It just so happens they share one very important feature.

#### **4-WHEEL DRIVE.**

Since it went into production almost 40 years ago, the Jeep vehicle has done wonders to promote the concept of 4-wheel drive.

Meanwhile, we're doing our part. Kubotas range from 12 to 81 hp. And no other manufacturer of mid-size tractors offers as many 4-wheel drive models as we do.

#### **TRACTORS WITH TRACTION.**

Of course, not all the jobs you do with a tractor require 4-wheel drive. But when you are operating in slick, muddy fields or on hilly terrain, you need all four of your tractor's wheels pulling for you.

And here's a further advantage. A 4-wheel drive Kubota can exert tractive power equivalent to a 2-wheel drive tractor with greater horsepower. In other words, 4-wheel drive can make your horses work harder.

In addition to 4-wheel drive on most models, Kubota gives you the qualities you expect to find in a full-fledged tractor. All Kubotas come with water-cooled

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If you want to find out more about the joys of 4-wheel drive, how it works, and what it can do, just ask your nearest Kubota dealer. Or, if you prefer, just ask your nearest friend who owns a Jeep vehicle.

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Kubota Tractor Corporation, 550 W. Artesia Blvd.  
P.O. Box 7020, Compton, CA 90224

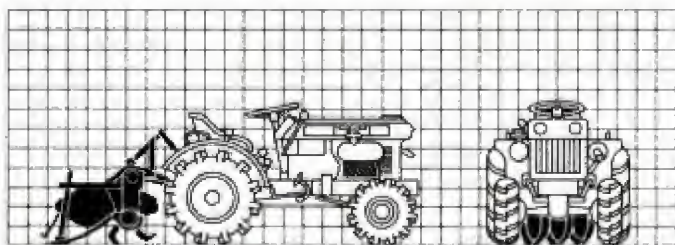
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AREA CODE \_\_\_\_\_ TELEPHONE NUMBER \_\_\_\_\_ PM5 \_\_\_\_\_

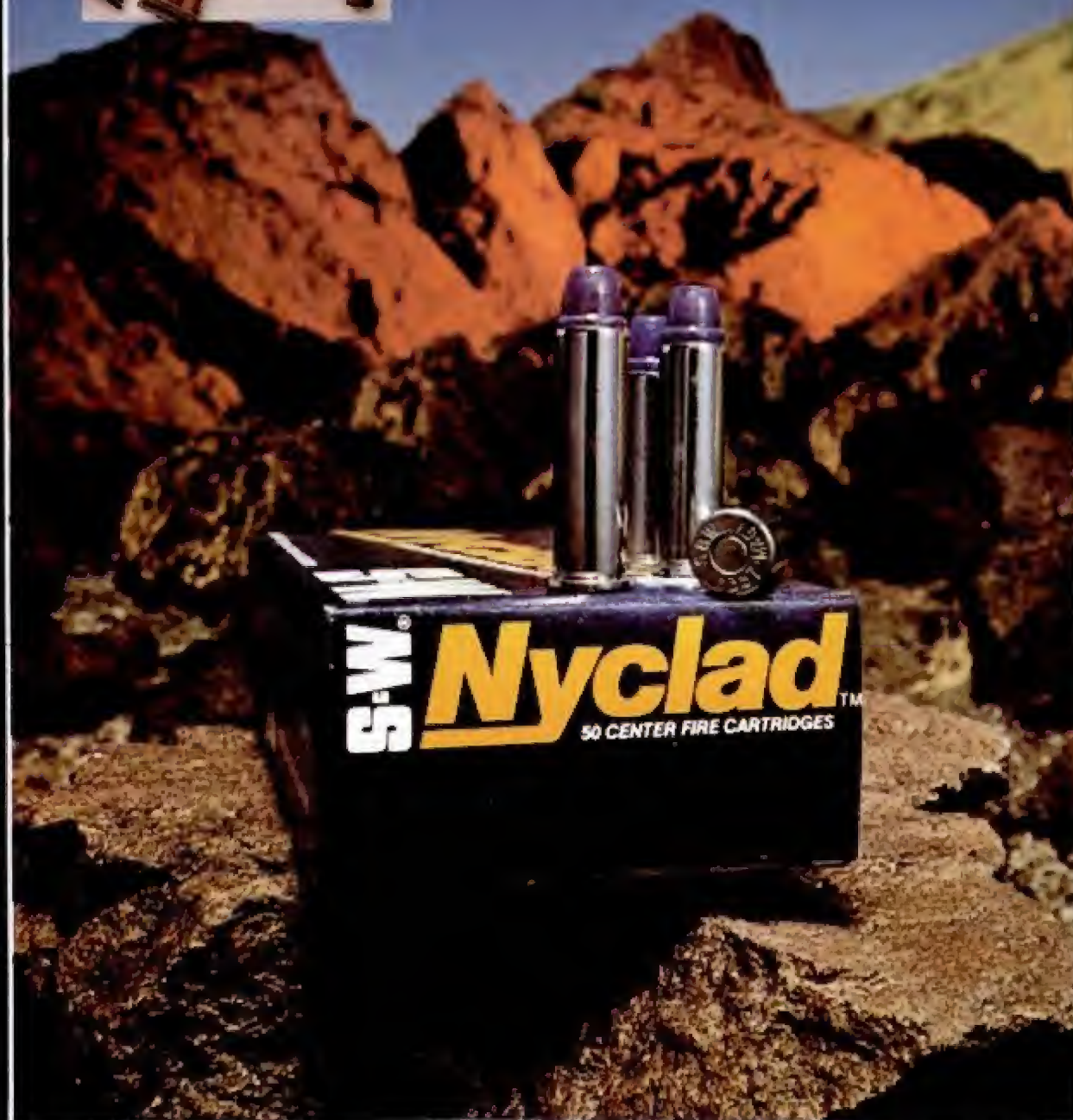
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## PM LOOKS AT WATER PRESSURE PLUNGER



Plunger action, combined with tap water, builds pressure to clean clogs.

I recently tried this new plumber's helper on a bathtub drain flow that had slowed to a trickle. Setting up was a matter of replacing the faucet aerator with the faucet adapter, making two hose connections and turning on the sink faucet. A handy on-off lever lets you turn on the water supply to the Splunger when you're ready to begin. With the tub partially full and the tub overflow stopped up, plunging action built up water pressure in the drain. After a dozen strokes, the tub was draining rapidly.

The unit (not including adapter and hose) costs about \$8 at hardware outlets. By Pacific Hardware Mfg., 184 Old County Rd., Belmont, Calif. 94002.—J. P.



A hose and faucet adapter are required for connecting Splunger to the faucet.

# The Great Whisky Made Like Great Wine.

No other whisky in the world is made like Old Forester. That's why no other whisky in the world tastes like Old Forester.

Old Forester isn't blended. It gets its color and flavor solely from the maturation process itself. It's made naturally, like Great Wine.

For example, Great Wine is matured under exacting conditions—to control temperature and humidity. So is Old Forester.

Most great French Wines are matured naturally—in oak barrels. Old Forester is matured the same way.

Great Wines are "canded" for color and clarity. "Nosed" for aroma and bouquet. They're bottled directly from the barrel. Never blended. And of course, they cost more.

This slow natural process is how some wines become Great Wines.

And how Old Forester becomes Great Whisky.





# THE TIGER THAT THRIVES IN TALL, TOUGH GRASS.



Hahn 30" Riding Mower  
Optional CatchMaster available.

Even lawns that look like tiny jungles are easy prey for the Tiger.

It maneuvers easily, with automotive-type steering. There's a rear engine for better traction. A floating front axle for mowing on uneven terrain.

All-gear, 3-speed transaxle has a 2-year limited warranty.

Let a riding Tiger or lawnmower turn your tall grass into a beautiful lawn.



**HAHN TIGERS**  
Tough Mowers For Tall Grass

Hahn Outdoor Products, P.O. Box 5004, Clemmons, NC 27012

## PM LOOKS AT WALLPAPER STRIPPER



As the stripper rolls over the wall, the blade bevel is always at the proper angle to lift paper without digging the wall.



Stainless-steel blade can be removed from housing for occasional honing.

**R**emoving wallpaper with a conventional scraper is a slow and tedious task. As you scrape, it's easy to make deep gouges in plaster or plasterboard. Later, you may have to go over your work and fill holes.

The Plasplugs Wallpaper Stripper promises to make stripping easier and quicker. The tool's design also makes it practically impossible to dig into the wall. The tool glides smoothly over the contours on a roller, while the blade is in continuous contact with the wall at the proper angle. Paper peels off in long strips with little effort.

When applying new paper, the roller can be used to smooth bubbles and press seams.—*Rosario Capotosto*

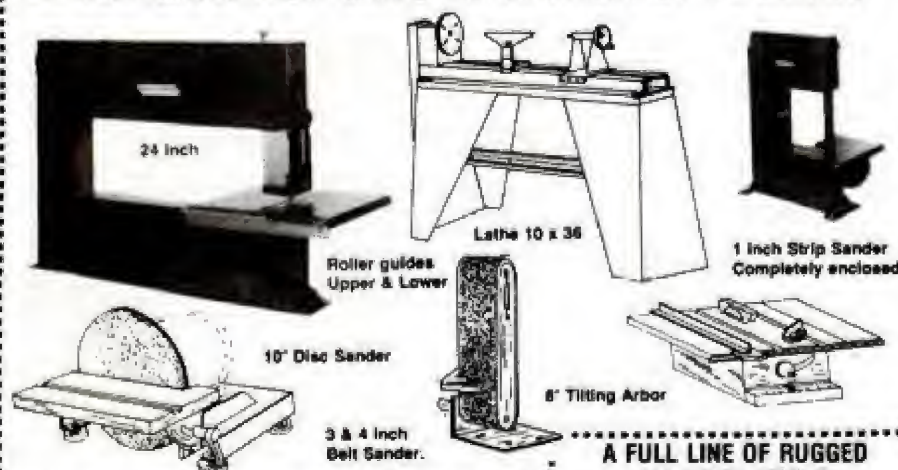
### SPECIFICATIONS—WALLPAPER STRIPPER

Housing: Molded plastic with detachable blade of tempered stainless steel

Price: \$10.95 at hardware stores; \$11.95 postpaid from the manufacturer

Manufacturer: Plasplugs Inc., 65 Montauk Highway, East Hampton, N.Y. 11937.

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Du-er's 24 inch Band Saw gives the handyman the versatility of an industrial tool at a price he can afford, the quality that is demanded by industry. The Band Saw, one of the best cutting principals for wood, metal or plastic, has been limited in use because of the depth of throat. The B-24's Big throat and new drive feature gives longer blade life, cuts metal, wood or plastic.

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# Frankly Speaking... Kmart has a deal worth listening to.

Unspeakably low prices on MacDonald Transceivers and Intercoms.

Get your message across with a MacDonald 5-watt, six-channel Transceiver with squelch control, charge switch, high-low battery saver switch, jack for external mike, 13-section whip antenna, volume control, channel selector and one pair of installed crystals. With the proper crystals installed, this transceiver will operate on any six of the 40 citizen band frequencies. Operates on eight "AA" conventional or ten rechargeable batteries (not included). Comes equipped with carrying case. At Kmart now,

**\$54.84**  
each



Who says talk is cheap? Kmart does! Spread the word with a MacDonald FM wireless Intercom System. It's a two-station, noise-free system, and both stations feature a pilot lamp, rotary on/off switch with volume control, beeping call button, press-to-talk button, and a lock button for continuous communication. Simply plug into any standard AC outlet. Kmart sale priced at

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a pair



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Your voice carries with a MacDonald two-channel CB Transceiver featuring rotary volume control, push-to-transmit button, channel selector switch, call signal switch, two pairs of crystals installed, a telescopic antenna and a swivel handle strap. Uses a 9-volt battery (not included). Sale priced now at Kmart,

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MacDonald Quality at a Kmart Price. Nice.

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6" and 8" heights.

## WOLVERINE TOUGH OUTSIDE PURE COMFORT INSIDE

The Wolverine is one tough customer and so are these boots. Because Wolverine® bred the spirit of the beast into every pair.

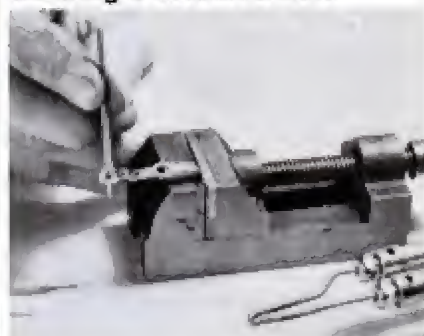
Made of rugged pigskin that is stronger, more scuff-resistant than cowhide. Pigskin actually "breathes" letting in fresh air. And with deep cushion insoles, you'll walk in comfort whatever the job demands.

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 **Boots & Shoes**

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## HINTS FROM READERS

### Clearing a soldered hole



Here's a stunt I saw a television repairman use to open a solder-clogged hole to insert a wire. First, heat the solder, then poke a wet toothpick through solder and into the hole.

After the solder hardens, remove the toothpick, insert your tinned wire and re-solder.—*Walter E. Burton*

### Ceiling tile holds knobs



Neatly paint wooden knobs and drawer pulls by first embedding their screws in a scrap of ceiling tile.—*Ken Patterson*

### Cleaning old window glass



Apply paint remover to old paint and putty remnants on window glass that is being recycled. Scrape off the softened material with a putty knife or razor blade.—*Arnold Sprite*



Now you can create country fresh air in your home or office. And also watch cigarette smoke, pollen, dust, and other airborne particles disappear from your environment, for less than three cents a week.

All it takes is a small 2½ pound pollution fighter named Ionosphere™. Which, we're convinced, is the most superbly engineered under \$200 air ionizer on the market today. Bar none.

The Sharper Image is offering Ionosphere through the mail for just \$89.

Ionosphere purifies the air you breathe more efficiently than any fan, exhaust unit or conventional filter system

by creating a negative electrical field. One 4-inch unit will ionize up to 250 square feet, or an average 12' x 20' room. This negative charge acts on floating particles—even invisible ones—causing them to cluster, fall to the floor or adhere to nearby surfaces. The air becomes pure, feels almost "washed." And Ionosphere is so efficient it requires no fan or other moving parts to disperse these ions.

You probably have experienced this fresh-air feeling before. In nature, negative ions are continually recreated by the dynamic action of the sun, rain and lightning. It's why air smells sweet and invigorating after a thunderstorm, or deep in a forest.

#### Born in academia.

Major ion research has been conducted at the University of California, Berkeley. Ion Systems, Inc., a private company, was founded to manufacture ionizers to the rigorous standards of this research community. Headed by senior engineer D.A. Gehlke (formerly with the government's Polaris Project), I.S.I. has built almost every hospital ion system in the U.S. Their new portable Ionosphere is constructed with this same level of integrity.

Ionosphere's electronics are both superb and unique. It is the only ionizer that uses "passive multi-stage" circuitry for its noiseless and noninterfering output (many units are known to affect radio reception). Most other units use a "vibration" mechanism, which causes clicks, pops or an annoying high-pitched whine.

The circuitry is embedded in epoxy resin, then encapsulated in an impact-resistant sphere—a solid seamless ball of fine ceramic tile.

Hermetically sealed, it is protected from the moisture that inevitably reduces the performance of competitive units.

We know of no other company that takes such pains in producing their product.

Other significant differences? For one, a vastly superior ion emitter than you'll find elsewhere. This easily removable element is made from surgical stainless steel bristle, not the more commonly used copper "fuzz" or nickel-plated points. (These have short life spans, do not clean easily, and in short time lower their output.) The Ionosphere's emitter will last a lifetime, and cleans easily under hot water.

On other units, you'll also find inexpensive plastic cases. When exposed to a high voltage field, these petrochemicals can be converted to a harmful gas. But Ionosphere's tile case is completely safe.

#### More ions aren't necessarily better.

One 4" Ionosphere generates approximately 3.8 trillion ions every second. Unlike other units which produce an excessively high output (at the source only), the Ionosphere creates a more *naturally* balanced ion environment. You should also avoid units without stated levels of ozone production (Ionosphere is among the lowest).



Power use: approximately 3 watts. Total ion output:  $3.8 \times 10^{12}$  ions/sec. Ion density: 10,000 ions/cubic centimeter at 8'. Ozone production: less than .03 ppm.  $N_2O$  production: not measurable.

#### Why do we need ionizers at all?

Urban life has upset the natural electrical balance of the air. Modern conveniences like heating, air conditioning, telephones and televisions greatly deplete negative ion levels, robbing the air of its natural cleansers. This is also why we feel uncomfortable under fluorescent lights.

Ionosphere restores this balance in just minutes. The air smells good again, even after smoking.

And, as a result of its work, you may need to clean your walls in a year or so. But be glad that same soot was kept out of your lungs.

#### Try one, or order a system.

The \$89 Ionosphere comes in white (#946) or black ceramic (#945). Or you may expand your fresh air environment at an \$18 savings—with three units at \$249; 2 white, one black, (#947). Either way, you can experience the freshest air you've probably ever breathed, without obligation. Ionosphere comes with full instructions and a one year warranty. And if you're not delighted, simply return your order within two weeks for a prompt and courteous refund.

#### ORDER NOW TOLL FREE.

Credit card holders may call the toll-free ordering number, seven days a week, anytime. Please have the product number ready. Or send your check, adding sales tax in CA (5.34 for one, 14.94 for three). Plus \$3.50 delivery. Please order now to insure early delivery.

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enable you to get your share of this always-profitable business. Hundreds we've trained are doing it. So can YOU.

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## THIS DO-ALL PRO KEY MACHINE YOURS TO KEEP!



Can add \$25 to \$40 a week to your income... and doesn't cost you a penny extra!

Introducing the Mini-Lock.

# It's every inch and <sup>3</sup>/<sub>8</sub> a Case.



The toughest thing about making the new Case Mini-Lock knife was making it to Case standards.

Over 150 hand operations go into the making of the Mini-Lock knife. And only the finest materials. The result is a pocket knife that's just 2 1/2" small when closed, a blade of 1 3/8" razor sharp surgical steel when open. It's lightweight but will stand up to heavy use.

If it seems like we went to a lot of trouble

Case — the officially licensed knife for the 1980 Winter Olympics.

for such a small pocket knife, consider the size of the reputation riding on it. After all, it's a Case.

For our pocket knife booklet, send 25¢ for postage and handling to W. R. Case & Sons Cutlery Co., Dept. O, Bradford, Pa. 16701.



The world's finest cutlery  
Made in America

## HINTS FROM READERS

### Paint helps secure joint



Oil-base paint applied to a wood joint acts as a filler and, to some degree, as a water-resistant adhesive. It reduces the chance of the joint coming loose.—Walter E. Burton

### Drill drives screw eyes



If you must drive a number of screw eyes, use an electric drill to make the job fast and easy. A piece of 1/4-in.-dia. aluminum serves as a bit. Cut a slot at one end to hold screw, and chuck the other end.—Ken Patterson

### Turntable painting aid



Next time you spray-paint a small item, try using a rotating cup hanger as a turntable to revolve the object as you paint it.

—Arthur Kapple



# Somebody needs what you've already got. Pass it on.



You came out of the service with a lot going for you. Skill. Knowledge. And experience. And much of it didn't come out of a book or a tech manual. It came from somebody else. Somebody who took the time to pass along what he knew.

Well, what about you? You've got a lot to give, too. And you can do it. Part-time. In the Army National Guard.

In the Army Guard, you can make a difference. By working with people who



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We're Plasti-Kote. We make a better quality spray paint. So you can spray on a better finish. We test for quality all through production. But our toughest tests are on your car...your outdoor furniture... your tools...your bikes, sleds, wagons. Plasti-Kote protects better because we give you better coverage, better staying power than ordinary spray paints. We know how because we're a leading maker of automotive paints—and automobiles are the toughest tests of all. You'll find us in the automotive department or the automotive store—quality spray paints for all indoor and outdoor jobs.



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"Most spray paints chip and flake when scratched. Ours doesn't. It's that simple."

Adhesion test authenticated by Nationwide Consumer Testing Institute. Unretouched photos magnified to show detail.





## PM's Whatsit

Our subject is not the missing link, although this one is certainly man-sized. In fact, chains of this dimension are commonly seen in parts of the United States because of equipment used in certain types of operations. Got any idea what kind? When pondering gets to be a drag, turn the page.

## Chickens of the sea



A research associate in the University of Georgia's Poultry Disease Research Center has discovered that seawater added to the drinking water of chickens strengthens their feathers. This means chickens are more likely to retain body heat and will thus yield more meat and eggs. Arthur Stattelmann, the researcher, found that chickens can tolerate up to 18 percent seawater in their drinking water but 10 percent is enough to alter the feather structure to the point where it will resist damage in crowded conditions.

Unlike some researchers, Stattelmann didn't ask his subjects to do anything he wouldn't do. Originally, he got interested in seawater by reading that its ingestion by humans (in limited quantities) benefits hair growth. Stattelmann puts two teaspoons of it in his orange juice every morning—and says it also makes the fingernails stronger and more flexible.

## Coming: A traceable bomb

*Bombing incidents, terrorist and otherwise, may seem rare and isolated in this country, but in fact, official statistics (for 1978) show 60 deaths and 260 injuries resulted from more than 2000 such bombings in a year. One of the difficulties for law enforcement agencies has centered on the lack of a means to trace the origin of explosives after they have been detonated.*

*But now that process may not be far from being perfected. General Electric Co. is testing the use of sand-sized magnetic particles to "tag" batches of explosive for later tracing, if necessary. The tiny, smooth particles are composed of magnetic ferrite alloys, each of which can be identified after surviving an explosion by its Curie point—the temperature at which, when heated, it loses its magnetism. These differences can amount to hundreds of degrees with only slight composition differences, but the GE system is sensitive enough to spot "tags" with Curie points only 10° apart. Thus, 30,000 discrete tags could be made from 15 basic ferrite compounds and mixed in with batches of explosive prior to leaving the manufacturer's facility.*

*The magnetic tags are also mixed with a phosphor that glows readily under ultraviolet light (see photo), enabling law officers at the scene of an illegal bombing to collect seemingly invisible particles for analysis. When perfected, the system should be put into wide use immediately—the magnetic particles will add only about one cent per pound to the cost of typical explosives.*





# IPM BRIEFS



## Whatsit revealed

The large chain is an essential part of what is known as a dragline, itself the essential apparatus for conducting strip-mining operations—in this case, for coal. The new dragline, one of the largest built, is now in operation at Thomas Hill, Mo., and the chain will retrieve a scoop bucket that holds 90 cubic yards of coal.

## Earthlings submit

The person who appears to be feeding peanuts to an extra-terrestrial elephant is actually a Goodyear Aerospace Corp. employee inspecting a Ballute. A Ballute? Yes, it's a cross between—aw, you can guess—and it has a very serious utilitarian purpose: Attached to bombs dropped from aircraft flying extremely low-level missions, the Ballute “inflates” itself in the high speed airstream, slowing the bomb’s descent while the plane that dropped it gets safely away.



## A \$40 mailbox that does the job

Both theft and the mystifyingly depressing growth of vandalism are a plague on the safe receipt of the U.S. mails in many parts of this country. David Trumper, who resides along RD 1 near Chester Springs, Pa., is one of those who has had it up to here—and decided to do something about it. With a standard 8-in. mailbox positioned inside of an 11-in. model, plus about 80 pounds of premixed concrete, Trumper built himself a high-security box at a cost of \$40 (note double door).

## PM follow-up: Butane lighters

Government agency memos substantiated it; a major wire news service had reported it; countless publications—unfortunately including this one (*PM Briefs*, page 52, March)—referred to versions of it. Now it appears there is no basis in fact for a story claiming that two employees of the Union Pacific Railroad engaged in welding operations were killed by exploding disposable butane lighters touched off by sparks.

In retrospect, it's easy enough to reason that if there were a serious safety hazard posed by disposable butane lighters—with millions of them carried and used

by Americans every day—we would have heard about it long before this. In accepting, like others, the bizarre coincidence along with the plausibility of the alleged accidents, PM erred on behalf of its readers, a number of whom own and use welding apparatus.

Penetration of the plastic case can allow the butane to vent from the lighter. But the National Burn Victim Foundation states that it has never received a report that a lighter exploded and caused an injury. The disservice done to specific interests and companies by the apparently unfounded basis for the earlier message is regrettable.



# Sears Best Central Air Conditioning.

## Generous with cooling.

## Stingy with energy.

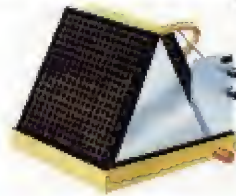
Summer is easier to take when keeping cool doesn't take a bundle of money. So have us arrange to install Sears Best Central Air Conditioning. It gives you the highest energy efficiency ratings and the lowest operating costs of any line we've ever offered. And that can help you save on your cooling bills.

**Cools efficiently, quietly and automatically.** A "Silent Sentinel" automatically keeps Sears Best Central Air Conditioning running at the proper speed for quiet operation. The exclusive "System Guardian" alerts you to potential operating problems. And our "Super Coil" provides additional cooling without the use of extra electricity.



*Call on Sears to arrange professional installation. Ask us now for a FREE estimate.*

**The right installation can add to your comfort.** You'll feel a lot better when you know your air conditioning system has been professionally installed for proper operation. Sears can arrange it. And we'll stand behind the system and the installation. What's more, you can buy it all on Sears Modernizing Credit Plan.



*The products and service described here are available at most Sears retail stores.*

**You can trust your house to**

**Sears**

Where America shops for Value



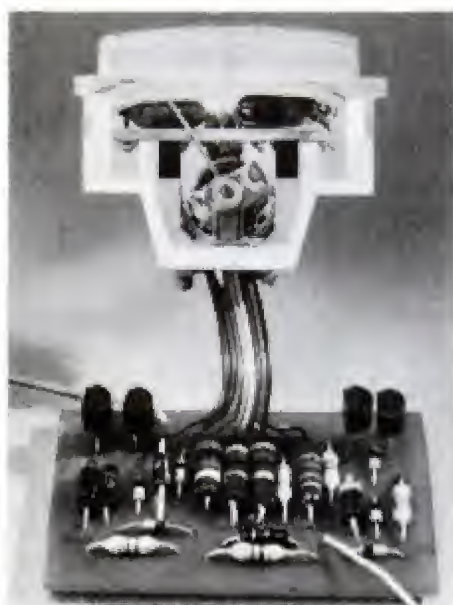




Pick up power with a cigaret-lighter plug and you can move Triple-Header from car to car. We used Velcro to hold it to dash.



The Triple-Header is unique. Behind its scale are red, green and yellow lights to signal changing electrical conditions.



Lights must be on a PC board or hand-wired behind meter. In order to use our PC board you have to employ a meter that is available separately from a kit.

# Build the 'Triple-Header' auto-voltmeter

You don't have to read this gauge to figure out your car's electrical system. Glowing lights tell the story.

by Jeff Sandler

**T**he *Popular Mechanics* Triple-Header Voltage Analyzer touches all the bases in keeping track of your car's electrical system. This triple threat uses a meter and three traffic-light colors—a language anyone can understand.

Our meter displays your car's voltage. Any malfunctions immediately move the voltage readings out of the normal range, and by noting "how" it happens, you will be able to diagnose exactly what component is at fault.

Of course, when you're driving, you should have your mind and eyes on the road. So we put a traffic light in the meter. Its scale glows green, yellow or red. Just install it where you can watch it out of the corner of your eye.

## Shedding light on voltage

Relax and drive on when the scale shines green, because your electrical system is in good condition. Yellow is an early warning that trouble is on the way (we'll show you how to diagnose exactly what). Red tells you that there's little time left before you'll be stuck on the road.

A yellow or red glow indicates your car's energy budget is out of balance and the output of the generator or alternator doesn't match what is consumed by the lights, fans and other electrical devices. Your battery must make up the difference.

This automatic switch to battery power is so smooth you rarely know anything is amiss. But soon the battery will be exhausted and then your car will be stopped dead.

What you want to know is the exact moment that you're running on battery power. Fortunately, the switch-over isn't so smooth it can't be measured. Once a battery is called on to put out (or absorb) power, its voltage changes "a little bit" as soon as the load is put on it. That's what sends the Triple-Header's needle flying on

the scale and turns lights from green to yellow or red.

## Starting off normally

When you turn the key in the ignition, but don't crank the engine, there is minimal current drain on the battery. Essentially you get its open-circuit (resting) voltage. For a good battery you'll read this as 12.5 volts and the Triple-Header's scale will be glowing yellow.

But the instant you crank, hundreds of amps. are drawn from the battery for the starter, and the Triple-Header's red light glows and the scale shows 8 to 10 volts. This is the *only* situation where the red light doesn't mean immediate trouble. In this case, it's telling you that you have proper cranking voltage from the battery.

If, however, your car is hard to start—and you had a prolonged bout of cranking—the voltage would fall still further. All the lights would go out on the meter scale (under 8 volts), and then you would know your battery is running down.

Once the car roars to life, the voltage regulator tells the alternator or generator to turn out lots of power to bring the lowered battery voltage back up to the 13.7 to 14.7 range. It doesn't take long for the battery to take a quick charge. Usually, within a minute, you're back from the red, through the yellow and into the green range. And it should stay in the green range for the rest of your ride.

We hope that you never see anything different on your Triple-Header than what we just described, but if you do, here's what to do about it.

## Starting problems

You go to crank the engine and nothing happens—except the Triple-Header's meter glows yellow. This tells you the battery is over 11

(Please turn to page 268)





# WHY OUR MACHINES KEEP ON GOING AFTER OTHERS STOP HERE.

As many machines half their age are heading for junkyards around the country, there are 25-year-old Gravely two-wheelers still on the job.

And quite a few '67 four-wheel garden tractors, the first ones we made.

Now, we can't guarantee that kind of future for every Gravely product we make, but we can tell you this:

On Gravely riding tractors, you'll find things you won't find on other lawn and garden tractors.

An all-gear direct drive through the transmission to the attachments.

So there are no belts to slip, break or wear out.

We use cast iron on the engine, transmission housing and the pivoting front axle.

The rear mounted engine is bolted directly to the transmission housing.

We use precision-cut gears, which operate in an oil bath for less friction and a longer life.

*Our 8153-T Riding Tractor.  
Twin cylinder power and smoothness.  
All-gear direct drive.*

The same kind of thinking goes into our two-wheel tractors.

As for mowers, we're not sure how long they'll last. Because we've only made them

for two years.

But we expect them to last a long, long time.

Because we don't build them any other way.

For more details, write Gravely, 547 Gravely Lane, Clemmons, North Carolina 27012.

Or look up the Gravely dealer nearest you in the Yellow Pages.

Either way you'll find one simple idea behind all our products.

We don't take shortcuts in workmanship.

Because that usually means taking shortcuts to the junkyard.

**GRAVELY.**



*Our 22" dual control mower  
features separate controls  
for blade and drive.*

*Our 1130-E Riding Mower.  
Three-speed all gear transaxle,  
unitized steel frame.*

*The Gravely Convertible.  
Cast-iron engine and  
transmission housing.*



# When your taste Winston out-tastes

Warning: The Surgeon General Has Determined  
That Cigarette Smoking Is Dangerous to Your Health.

100's: 18 mg. "tar", 1.3 mg. nicotine, KING: 20 mg. "tar",  
1.4 mg. nicotine, av. per cigarette, FTC Report DEC. '79.





grows up,  
them all.

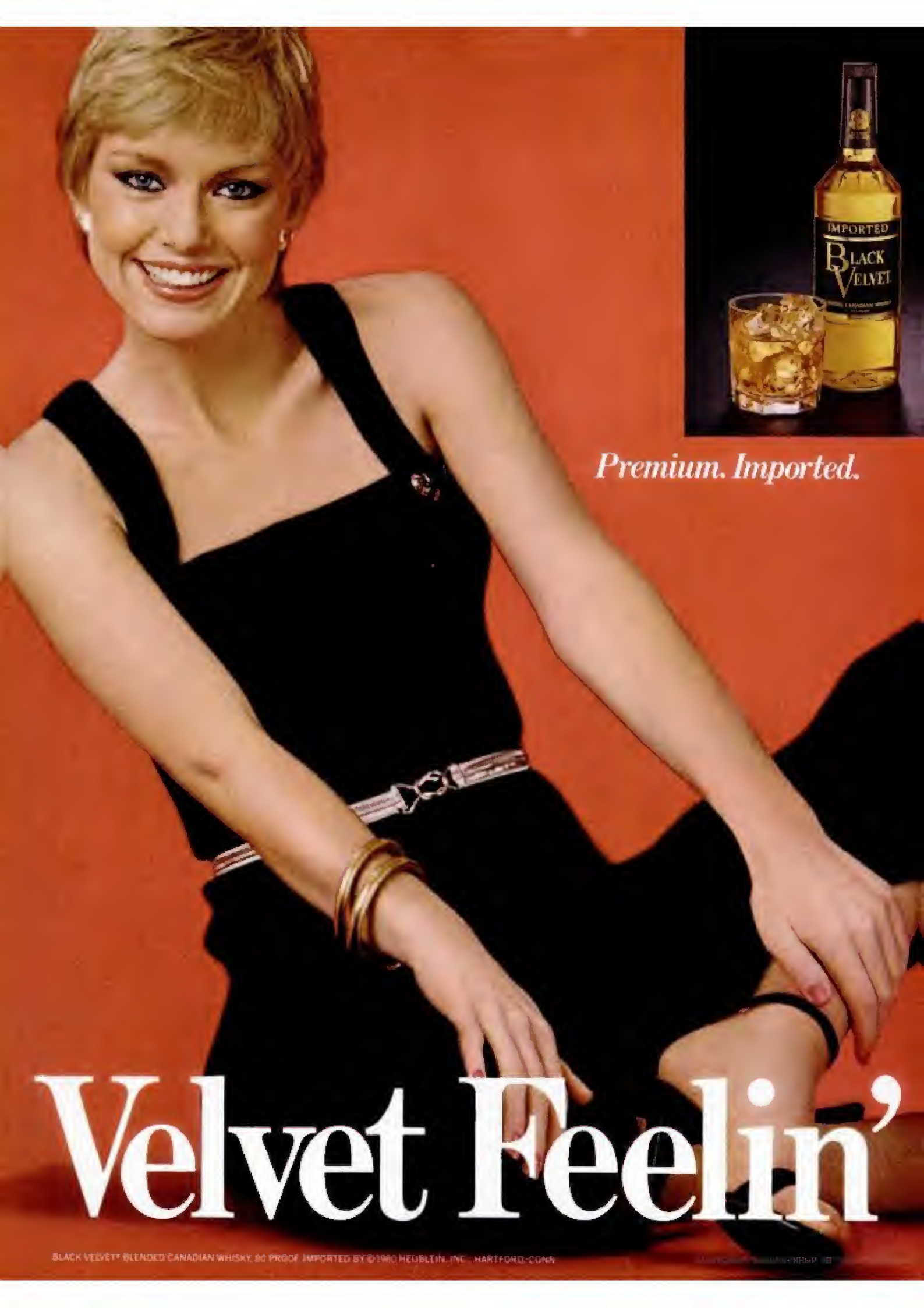
Only Winston's Sun-Rich™ Blend  
of the choicest, richest tobaccos  
tastes this full and satisfying.

**Winston after Winston.**



Regular and 100's





*Premium. Imported.*

# Velvet Feelin'

BLACK VELVET® BLENDED CANADIAN WHISKY, 80 PROOF, IMPORTED BY ©1990 HEUBLEIN, INC., HARTFORD, CONN.

BLACK VELVET® BLENDED CANADIAN WHISKY, 80 PROOF





# Hot new .22s for better shooting

Among the many popular .22 cartridges that are available: (1) CB Cap; (2) Remington Short; (3) CCI Mini Cap CB; (4) Winchester Western Super-X Hollowpoint; (5) Eley Tenex Match; (6) CCI Stinger;

(7) CCI Hollowpoint; (8) Remington Shot load; (9) Winchester Western Long Rifle Wildcat; (10) Remington Yellow Jacket; (11) CCI Long Mini CB; (12) Remington Short High Speed.

These potent plinkers now are faster and more versatile than ever before.

by Angus Laidlaw

**T**he most popular modern cartridge in the sportsman's arsenal has to be the .22 rimfire. It is also the oldest cartridge available—and the newest.

More shooters fire .22 rimfire rifles and handguns than any other caliber. As it was in the beginning, the reason is simple: It costs less than any other form of real shooting. And it most certainly is real shooting. The cartridges that fit in the long-rifle chamber of your .22 have taken every kind of North American game from mice to

moose—although far more rats and varmints fall to them than do larger game.

Your long-rifle chambered handgun or long arm is one of the most versatile guns to own. Currently loaded ammo ranges from BB (ball bullet) and CB (conical bullet) caps, which are only slightly hotter than air-rifle loads, to the recently introduced hypervelocity Stinger, Xpediter and Yellow Jacket rounds. Potency ranges from the ancient, minuscule BB cap (first loaded in 1845) that fires an 18-grain, round ball at 780-feet-per-second (f.p.s.) muzzle velocity up to 1687 f.p.s. for CCI-Omark's Stinger, first introduced in 1976. In between come the traditional short, long and long-rifle cartridges known to generations of .22 shooters, plus interesting, little-known specialties, shot loads and blanks.

The .22, in fact, offers almost as much versatility in ammo as it does in guns to shoot it. And if three cents per round for the cheapest .22 shells up to 11 cents each for Eley's match cartridges sounds like a lot—compared to the preinflation 50 cents for a box of 50—just think of the 50-cents-per-bang prices that are being paid for the higher-powered rifle cartridges today.

## The hot ones

Biggest news in .22 ammo has to be the hypervelocity loads now available. At almost any shooting range or gunshop, there are shooters who swear by any of the three available brands. They have good cause: Most .22 rifles and handguns have distinct ammo preferences. What works wonders in one gun

(Please turn to page 50)







**bass**  
GARCIA MAKES IT SIMPLE.

**Striper**  
GARCIA MAKES IT SIMPLE.

**salmon**  
GARCIA MAKES IT SIMPLE.

**walleye**  
GARCIA MAKES IT SIMPLE.

**trout**  
GARCIA MAKES IT SIMPLE.



<sup>1</sup> *Journal of the American Statistical Association*, 1997, 92, 1036-1046.





## Ford LTD wagon and the option that could pay for itself.

## The luxury of long-term protection.

## Just ask your Ford Dealer.

When you order your new Ford LTD wagon, be sure to consider the one option that could pay for itself. Ford Motor Company's Extended Service Plan. It's available to help protect you against rising service costs. And it's backed by Ford Motor Company and honored by participating Ford Dealers nationwide.

To learn more about what this plan covers and what it costs, see your Ford Dealer.

The option that  
could pay for itself.



**EXTENDED  
SERVICE  
PLAN**

### HOT NEW .22S *(Continued from page 47)*

throws fliers from every target group in another example of the same make. This goes for the older shorts, longs and long-rifle cartridges as well.

Assuming a gun is in good shape, clean, and has showed itself capable of accuracy with groups of an inch or less at 25 yards, the chances are that one of the three brands of hot-velocity cartridges will suit it. One of the three may also not work well at all. So the best move is to buy a box or two of each right at the start. Then, as hand-loading expert John Wooters puts it, you "ask your rifle" which it prefers.

What do you buy? First on the scene was the CCI-Omark Stinger. Then came Winchester Western's Xpediter, followed by Remington's Yellow Jacket. Going rate is about a penny a round more than standard or high-velocity .22 long-rifle loads.

What do you get? Lighter bullets going faster can mean very nearly .22 magnum performance at much less cost for a special rifle. The advantages are longer effective range on small game up to 150 yards, flatter trajectory for more hits with less holdover, better wind-bucking and more power. Accuracy and improved functioning in automatics also are among the benefits.

The basic .22 cartridge is an old de-

sign. There are many antique and semi-antique arms chambered for it. To prevent accidents from overloads, the Sporting Arms and Ammunition Manufacturers Institute (SAAMI) specifies a maximum pressure to which any standard cartridge can be loaded. This is a worthwhile safety feature, but it has limited the development of higher-velocity cartridges.

Then CCI-Omark engineers came up with an answer. It has a somewhat lighter bullet than the standard 40-grain, long-rifle slug, in a slightly longer case, but with the same outside dimensions so that it would fit standard chambers. And since the fast powders used in .22s burn out in 16 inches or less traveling through barrels of 20 inches or longer, slower burning powders could be the answer. Then bullet velocity is increased by extending the push on the lighter slug rather than by raising the combustion pressure to dangerous levels while pushing the bullet harder.

After a lot of experimenting, CCI-Omark developed the highly successful Stinger. It has a 32-grain, hollowpoint bullet in a case 1/10 inch longer than the standard long-rifle case. Specially developed powder keeps on pushing the bullet all the way out a 20-, 22-, or 24-inch barrel. The result is a 1687-f.p.s. muzzle

*(Please turn to page 57)*

### HOW VELOCITY AFFECTS BULLET DROP

Cartridge	Bullet Weight (grains)	Muzzle Velocity (ft./sec.)	Muzzle Energy (ft.-lb.)	Midrange Trajectory (in.)	Velocity at 100 Yards (ft./sec.)	Energy at 100 Yards (ft.-lb.)
.22 Short (Standard Velocity)	29	1045	70	4.8	872	49
.22 Short (High Velocity)	29	1095	77	4.5	903	52
.22 Short (High Velocity, Hollowpoint)	27	1120	75	4.4	904	49
.22 Long (High Velocity)	29	1240	99	3.9	961	59
.22 Long Rifle (Standard Velocity)	40	1150	117	4.0	975	84
.22 Long Rifle (High Velocity)	40	1255	140	3.6	1016	92
.22 Long Rifle (High Velocity, Hollowpoint)	37	1280	135	3.5	1013	84
Winchester Western Dynapoint Super-X	40	1255	140	3.6	1016	92
Winchester Western .22 Xpediter (Hollowpoint)	29	1680	182	2.5	1079	75
Remington Yellow Jacket (Truncated Cone, Hollowpoint)	33	1500	165	2.8	1075	86
CCI-Omark Stinger	32	1687	202	2.2	1158	78
.22 Short GB	29	715	—	—	—	—



# Long-range luxury. 1980 Ford LTD.



LTD Country Squire

## Best mileage of any full-size wagon.

Fifty years of Ford wagon technology come together in the 1980 LTD. It's versatile, good-looking and practical with even better mileage than last year—the best of any full-size wagon.

**17**

EPA  
EST.  
MPG

**24**

EST.  
HWY.  
MPG

For comparison excl. diesels and other Ford Motor Co. wagons. Your actual mileage may differ depending on speed, distance and weather. Actual hwy. mileage will probably be lower than est. Calif. mileage lower.

## Unsurpassed room.

No wagon sold in America has more passenger or cargo room than LTD. Based on EPA volume index (112 cu. ft. passenger, 53 cu. ft. cargo). And LTD Wagons are rated to tow up to 6,000 lbs. with an optional towing package.

See your Ford Dealer and ask about the Extended Service Plan.



Better Ideas for  
the 80's FORD.

**FORD LTD**

FORD DIVISION



**340**-Mile Est. Range; **480**-Mile Est. Highway Range. Based on LTD's 20-gallon gas tank and EPA mileage estimates. Your range may differ. Actual highway and California range will probably be lower.

P R N D 3 1

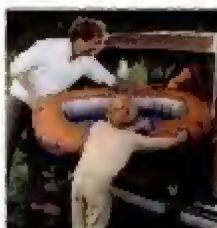
**Automatic Overdrive Option.** First fully automatic transmission with the benefit of overdrive on an American-built car.



**LTD Luxury.** Optional Interior Luxury Group shown with rich velour cloth, available in super-soft vinyl or optional leather.



**Cargo Room.** With the tailgate down, you can actually slide in a 4' x 8' sheet of plywood ... flat.



**3-Way Tailgate. Dual Facing Rear Seats.** Tailgate swings open like a door or down like a platform. Dual facing rear seats, an exclusive Ford Motor Co. option, provides seating for two or an extra 7.7 cu. ft. of under-floor stowage (with seat cushions removed).



# A third less tar than the leading filter 85



**Longer, yet lighter**

Pall Mall Light 100's	12mg. tar 0.9mg. nic.
Winston 85	20mg. tar 14mg. nic.
Lowest brand	less than 0.5mg. tar 0.05mg. nic.



## PALL MALL LIGHT 100's

Warning: The Surgeon General Has Determined  
That Cigarette Smoking Is Dangerous to Your Health.

12 mg. "tar", 0.9 mg. nicotine av. per cigarette, FTC Report Dec. '79.



## STURDY LATHE STAND

Used shop items can often be picked up at tag sales and estate auctions for a song. The lathe stand shown here was acquired by PM reader and contributor Guy

Lautard from the estate of an amateur machinist. We felt that the simple, sturdy design was one we should share with our readers.

Although the stand was originally made for an Atlas lathe, which measures 11×17×34-in., very little work was required to adapt it to the smaller Myford lathe shown in the photo. Two layers of ¾-in. plywood provided a sound table, and wooden blocks, bolted to the floor, brought the centers to a good working height.

When you dimension the stand to suit your lathe, the length of cross members (A) should be such that the lathe's headstock is directly above plate E and the tailstock rests above plate D. Adjust the lengths of the three uprights so that the foot plates can be mounted directly to the floor while maintaining a 50-in. (approximate) center height.

### Welded-steel construction

The drawings give all pertinent dimensions for the stand. Construction is of steel pipe and steel plate.

Cut all parts to lengths shown and assemble by welding them. Be sure that the top plates end up level and

in the same plane. On-hand materials can be substituted for those in the materials list (below).

Even 2×3-in. rectangular steel tubing (.095-in. wall thickness) could be used for a lighter stand of adequate strength. The heavier the materials, however, the quieter and more vibration-free the performance.—*Joseph R. Provey, Assistant Home and Shop Editor*

### Plans offer

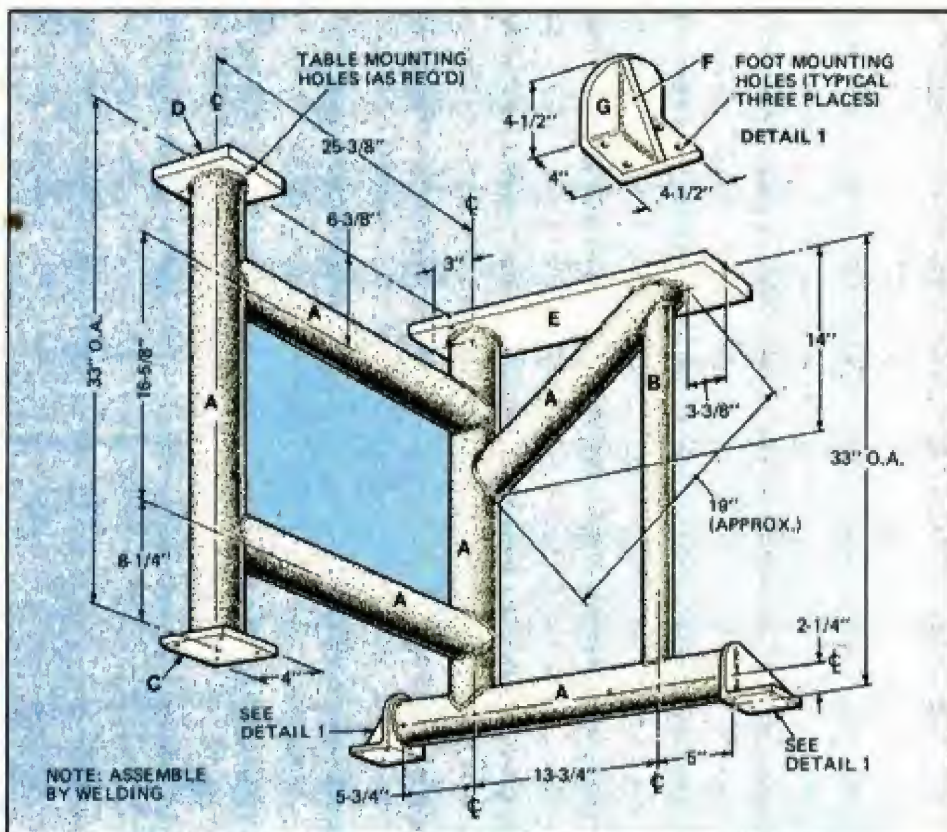
Metalworking projects, such as this lathe stand and the filing stand on page 55, require a lot of cutting. PM offers plans for a low-cost, power hacksaw for \$3.75 postpaid. Write to Popular Mechanics, Dept. JP580, Box 1014, Radio City Station, New York, N.Y. 10019.

### MATERIALS LIST—LATHE STAND

Key	No.	Size and description (use)
A	(as req'd.)	3½" o.d. iron pipe (stand frame)
B	(as req'd.)	2" o.d. iron pipe (stand frame)
C	1	¾ × 4 × 4½" steel plate (foot plate)
D	1	¾ × 6 × 8" steel plate (top plate)
E	1	¾ × 7 × 20½" steel plate (top plate)
F	2	¾ × 3½ × 4½" steel plate (brace)
G	2	¾ × 4 × 4½ × 4½" steel angle (foot)



Lathe stand is raised to preferred work height (50 in. to center) with wood blocks and leveled with 1½-in., sheet-lead shims.





## TOOL CADDY FROM SCRAPS

**R**epair jobs around the home often require trips back to the workshop for forgotten tools or supplies. The tool caddy here should eliminate such wasted time. It not only totes a wide assortment of tools, but also organizes fasteners and spare parts. Since the organizers are interchangeable, you can fit out the caddy for specific tasks.

Construction of the caddy is sim-

ingenious tool caddy organizes hammer, hacksaw, ruler, tape measure and other hand tools, as well as supplies like tape, glue, and a wide assortment of washers and fasteners.



The modular tool and supply organizers (1) that make up this caddy are cleverly made from coffee- and soup-size cans. First glue a hardboard disc to the smaller can's bottom (2) to keep it centered



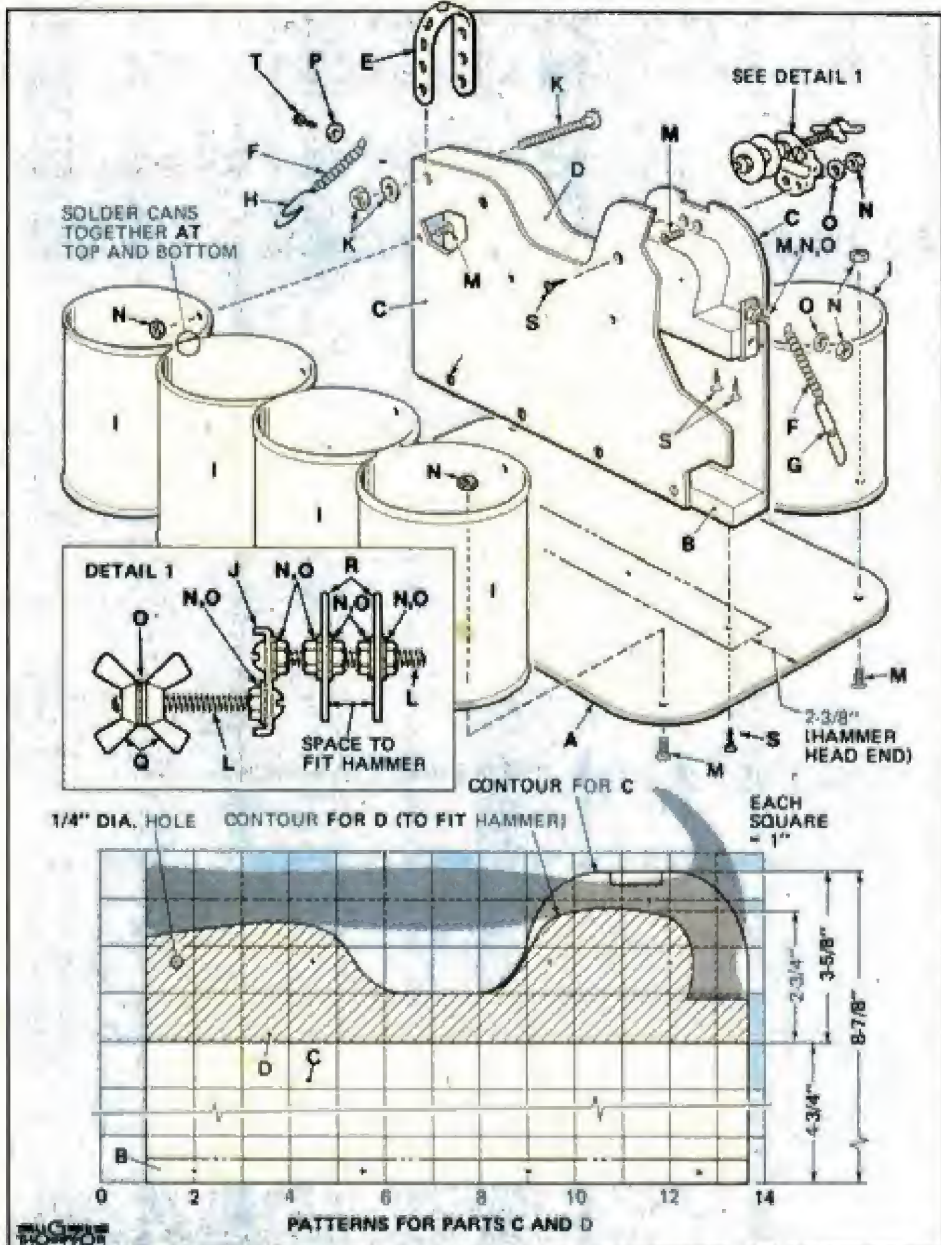
inside the larger can. Use three small bolts, 120° apart and installed just below upper rim to serve as top-side spacers (3). Then fill a glass jar with supplies and place in the small can (4).

ple, but attention must be paid to the clever latches and retainers for the saws and hammer. The hammer, which also serves as the caddy handle, is held in place by pipe strapping at the handle end and by a spring-loaded latch at the neck (see detail in plans). A strap and buckle or an L-shaped steel bar installed in slots cut above the hammer's neck in the cradle will also work. The protruding end of corner brace (U) keeps the hammer from sliding forward.

A machine screw (M), brazed to the corner brace, serves as an anchor for spring F. Two chain links (G) fasten to the spring and engage the blade-tensioning bolt on a hacksaw. A similarly devised hook secures the backsaw at the other end of the caddy. Instead of chain links, a hook bent from hanger wire engages the saw handle.—Fred Haitz

### MATERIALS LIST—TOOL CADDY

Key	No.	Size and description (use)
A	1	1/4 x 9 1/4 x 15 1/4" hardboard (caddy base)
B	1	1/4 x 1 x 12 1/4" pine (saw-holder base)
C	2	1/4 x 8 1/4 x 12 1/4" hardboard (saw-holder sides)
D	1	1 x 2 1/4 x 12 1/4" overall (hammer cradle); sandwich 1/4" pine between 2 pieces of 1/4" hardboard
E	1	3" pipe strapping (handle retainer)
F	2	1/4"-dia. x 2" spring
G	1	2-link piece of chain (to catch on hacksaw)
H	1	hook bent from stiff wire (to catch on backsaw)
I	8	4" dia. cans
J	1	self-closing cabinet hinge
K	1	1/4-20 x 1 1/2" machine screw, nut and washer
L	2	No. 8-32 x 1 1/4" machine screw
M	15	No. 8-32 x 1/4" machine screw
N	22	No. 8-32 hex nut
O	11	No. 8 external-tooth lock washer
P	1	flat washer
Q	2	No. 8-32 wingnut
R	2	1" o.d. flat washer
S	20	1/4" No. 8 flt. screw
T	1	No. 8 pan-head screw
U	1	corner brace





## TIP-PROOF VACUUM DOLLY



Use the three-wheel dolly for shop vacuums up to 15-gal. models. Use the four-wheel version for the larger units.



### MATERIALS LIST—VACUUM DOLLY

Key	No.	Size and description (use)
A	1	$\frac{3}{4}$ x 17 $\frac{1}{2}$ " dia. plywood (base)
B	1	$\frac{3}{4}$ x 4 $\frac{1}{2}$ x 8" pine (small caster support)
C	2	$\frac{3}{4}$ x 2 x 20 $\frac{1}{2}$ " pine** (caster support)
D	1	$\frac{3}{4}$ " IPT x 3" dia. stem-type caster*
E	1	$\frac{3}{4}$ " IPT connector*
F	1	$\frac{3}{4}$ " IPT nipple*
G	1	$\frac{3}{4}$ " IPT floor flange*
H	3	$\frac{1}{4}$ -20 x 1 $\frac{1}{2}$ " machine screw, nut, washer*
I	3	$\frac{1}{4}$ -20 x 2" machine screw, nut and washer*
J	2	$\frac{3}{4}$ x 2 x 5" pine**
K	2	$\frac{1}{4}$ -20 x 3" fl machine screw, nut and washer**
L	2*	2" or 4" 6" dia. plate or stem-type caster
M	3*	3" or 5" $\frac{1}{4}$ -20 x 2 $\frac{1}{2}$ " machine screw, nut, washer
N	1	$\frac{1}{2}$ " IPT waste nut
O	1	$\frac{1}{2}$ " IPT x 2 $\frac{1}{2}$ " nipple
P	1	$\frac{1}{2}$ " IPT x 90° elbow
Q	1	$\frac{1}{2}$ " IPT pipe, length to suit
R	1	$\frac{1}{2}$ " IPT x 45° elbow
S	1	$\frac{1}{2}$ " IPT x 6" pipe (thread one end only)
T	1	$\frac{3}{4}$ " IPT connector
U	1	$\frac{1}{4}$ x $\frac{1}{2}$ x 2" strap iron
V	2	No. 6-32 x $\frac{1}{4}$ " fl machine screw
W	1	No. 10-32 thumb screw
X	2	$\frac{1}{4}$ -20 x 3" fl machine screw, nut, washer

\* 3-wheel dolly only

\*\* 4-wheel dolly only

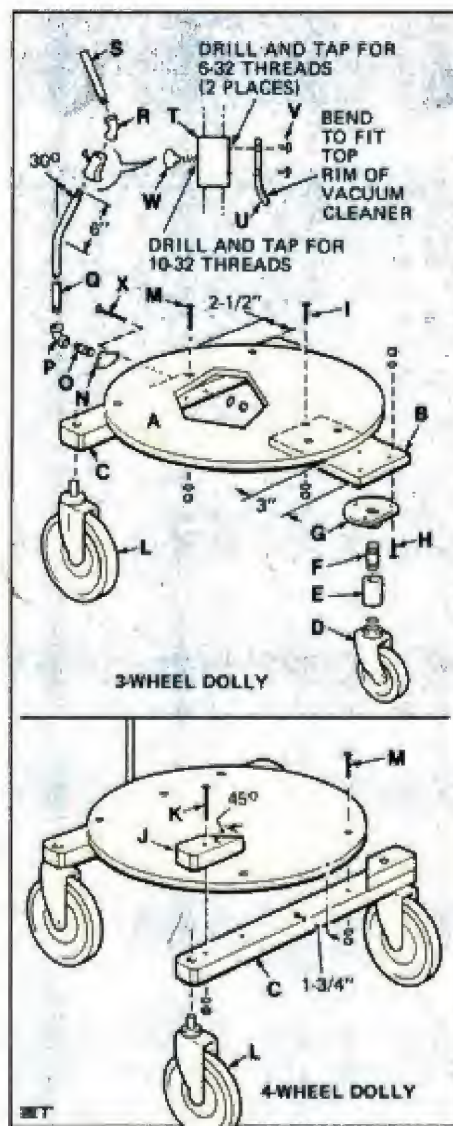
Note: If necessary, change the dimensions of materials A and Q to suit your own shop vacuum.

The two vacuum dollies shown here were designed to roll over typically cluttered shop floors without tipping over. Large-diameter casters and a wide span between wheels do the trick.

Construction is basically the same for both versions. First cut the plywood disc to the diameter of the recess in the bottom of your shop vacuum. If your vacuum has no recess or if you desire extra stability, plan to add the retaining blocks (J) shown on the four-wheel dolly.

Cut the caster-support members and bolt them to the plywood disc. Install the casters and check to be sure the dolly platform is level.

(Editor's note: Although stem-type casters were used since they were on hand, plate-type casters would be better. Cut caster supports (C) to suit the plates.)



The length of the pipe upright depends on the height of your vacuum. It should terminate about 6 in. above the vacuum's top.

To install the rim-clamp assembly, drill and tap connector (T) as shown and slide it onto the upright pipe (Q). Attach strap iron (U), which has been bent to suit the vacuum's top rim. Install the thumbscrew (W) to lock the clamping assembly at the proper height. To remove the vacuum from the dolly, simply loosen the thumbscrew and slide the connector and strap clamp off the rim.—C.E. Banister

## UNIVERSAL FILING STAND

This stand will let you get that "just right" angle for many filing jobs. It has two adjustments—the ball for fine and the yoke for coarse adjustments.

All materials used to build the stand were from the junkyard except the ball hitch, which came from Sears, Roebuck and Co. The yoke

came from one half of a universal joint from a semitruck. Although no part size is critical, some parts must be matched together. Use the largest and heaviest parts you can find to increase stability.

Start by cutting and welding together angle iron to form the legs (A). Then position and level the

three legs and lightly tack them together at 120° angles. Insert the center post, square it up, and tack-weld it. Recheck for squareness and then finish welding.

An adjustable-height office chair was used for the seat. Put bushing (G) in one end of the seat support (C) and drill it out to fit the adjusting



The rack for the toolholder is a tray from a refrigerator with its

Make borings in the universal joint (I) and pin (J). Add collars (K) to the pin (one welded, one threaded) and complete the head assembly as

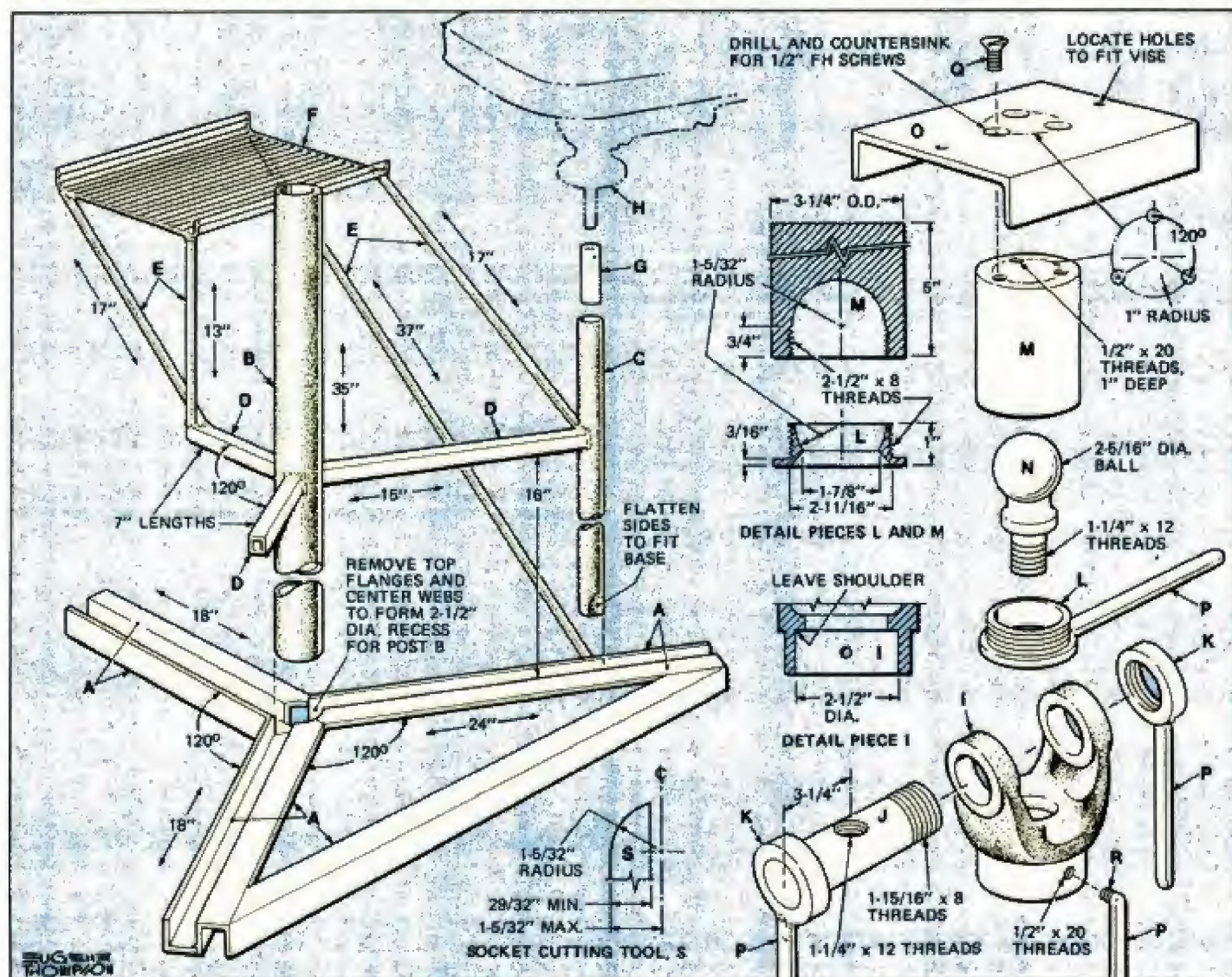
Bolt the channel iron table (O) to the head (M) and mount your vise. Finally, position the handles so they are pointed away from the operator and will not be in a position to interfere with the use of the filing stand.—Willard Martin.



Filling stand combines universally adjustable table for vise, a handy tool station and a seat that rotates for desired comfort and mobility, all combined into a single, useful unit.

Key	No.	Size and description
A	1	1/4 x 1 1/2 x 14" angle iron (cut to length shown in plans)
B	1	2 1/4" o.d. x 3" pipe (or to suit)
C	1	1 1/2" o.d. x 2" pipe (or to suit)
D	1	1 x 1" or 1" o.d. x 30" pipe (cut to lengths shown)
E	1	1/2" o.d. x 7" pipe (cut to lengths shown)
F	1	12 x 16 1/2" refrigerator tray (cool station)
G	1	4" long bushing (drill out for office-chair screw)
H	1	office-chair or drafting-stool top
I	1	yoke from universal joint of semitruck
J	1	1 1/4" or 2" o.d. x 7 1/2" steel rod
K	2	5/8" x 2 1/2" dia. steel
L	1	1" x 3 1/4" dia. steel
M	1	5" x 3 1/4" dia. steel
N	1	ball from trailer hitch
O	1	2 x 6 x 8" channel iron (vise table)
P	4	1/4 x 1/2 x 8" flat stock
Q	3	1/2-20 x 1" in machine screw
R	1	1/2-20 x 1" setscrew
S	1	1/4 x 1 x 8" flat tool steel

**Note:** Change lengths of B and C to suit your height.





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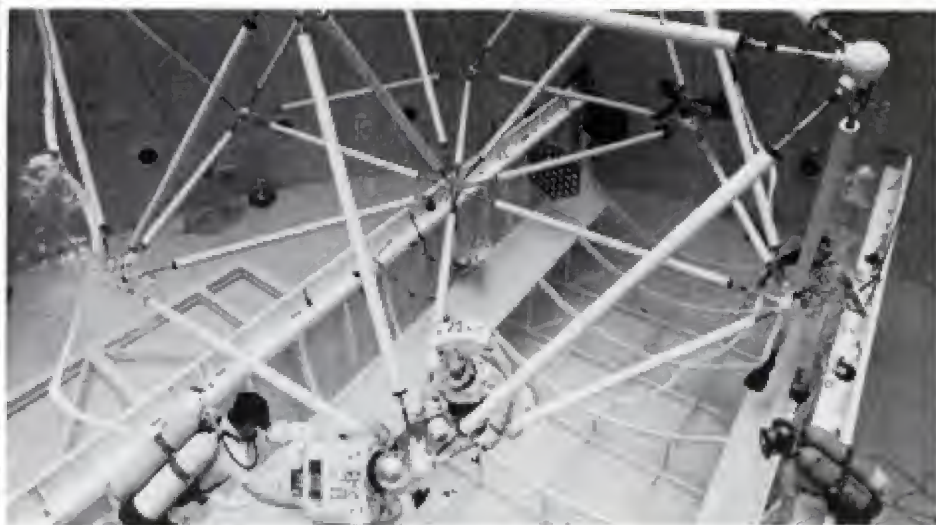
WHEN YOU'RE HEADING HOME,  
EVEN THE SKY SEEMS TO SAY  
IT'S TIME FOR RED.

**JOHNNIE WALKER RED**  
THE RIGHT SCOTCH WHEN ALL IS SAID AND DONE





# SCIENCE WORLDWIDE



Students achieved high productivity in the underwater conditions simulating outer space.

## Weightless work

Underwater research by a group of students suggests that in some ways it'll be easier to build structures in space than skyscrapers on Earth—provided the space workers dress right.

The students, from the Massachusetts Institute of Technology, built a large tetrahedral structure in the 1.3-million-gallon tank at NASA's Marshall Space Flight Center. The tank simulates the zero-gravity environment of space.

Results of the experiment are encouraging for the future of construction projects in space. (See *Our Next Steps in Space: Zero-G Factories and Asteroid Mines*, page 114, June '78.) Graduate student Dave Akin told PM that even when wearing bulky spacesuits, "people are very productive—a factor of 10 more productive than people doing equivalent tasks on Earth, for example assembling the steel girders of skyscrapers." Weightlessness hikes productivity, he said, "because there's no effort holding the pieces up. All you're doing is maneuvering them into position."

But simulated space work had its problems for the seven researchers. The main problem, Akin reported, was ill-fitting spacesuits, borrowed from astronauts. Akin sprained a finger just trying to jam it into the glove of Vance Brand's suit.

Student Mary Bowden all but disappeared in Owen K. Garriott's space garb and had to put on thickly padded underwear to fill out empty space inside.

The student research complements Skylab studies showing that

weightless crews lose little muscle function if they work out on treadmills, bicycles and other gym gear aboard their spacecraft.

## Shouldering the robot's burden

Another approach to space construction, of course, is to let robots do it.

Dr. Delbert Tesar, director of the University of Florida's robotics center, thinks it's possible. Tesar told us



Tesar's mechanical shoulder: Future robots, hardly moving, might aid in surgery.

some future astronaut might build a model of a large space structure using a computer display while robots duplicated the construction in space using full-scale parts. In another application, microsurgons of the future might hook themselves to a robotic three-inch-long arm. If the surgeon moved his hand an inch, the robot would move a thousandth of an inch. Stepping down human actions would greatly increase control in delicate brain operations, Tesar said.

Tesar's lab is developing robotic parts, including a strong mechanical shoulder with the ability to duplicate the roll, pitch and yaw of a human joint. In a robot-microsurgeon's arm, it would be shrunk to the size of a dime.

## Filling the trough with energy

A new trough-like solar collector with a curved back like a funhouse mirror has achieved record efficiency in converting sun power to useful thermal energy.

Sandia Laboratories' parabolic collector converts 60 percent of the solar energy striking it into 600° F. heat in a receiver tube at its focus. Until now, the highest efficiencies recorded from such trough-like collectors has been between 40 and 50 percent.

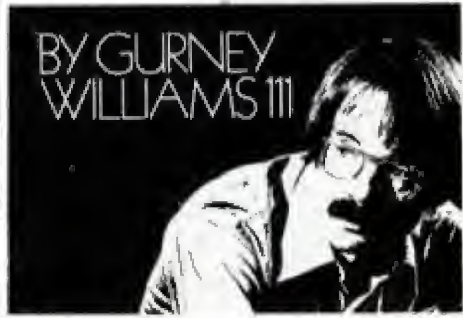
Key to the collector's success is a highly reflective (and at this point expensive) glass, according to Sandia's Sam Martin. Why does most solar energy bounce from it without getting lost in the glass? A spokesman for the mirror's maker, Corning Glass Works, said it contained less energy-absorbing iron than other mirrors.

## Senseless sentences

If you read a sentence that makes no sense—"He spread the warm bread with socks," for instance—a distinctive tremor appears in your brain waves when you trip over the incongruous word.

That's the finding of University of California researchers Marta Kutas and Steven Hillyard, who flashed odd sentences ("He took a sip from the transmitter") at subjects wearing scalp electrodes. Discovery of the brain-wave tremor could help therapists find out whether people with reading difficulties are able to comprehend what they read.

Presumably, this new tremor could also be used to determine whether proofreaders are performing up to socks. **PM**





# Is this the world's most efficient screwdriver?



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_____	4"	3.75	_____	12"	10.00
_____	5"	4.25	_____	SPECIAL!	
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# More tomatoes from less space



Grow-ring system has boosted tomato harvest 250 percent for many, maker says.



Six-sided grow ring, filled with organic waste from yard, garden and kitchen, acts as a compost and trellis for plants.

**A** grow-ring system has five advantages over conventional ways to grow tomatoes. First, it is a receptacle for organic waste. Second, it decomposes the matter aided by composting flakes to provide rich humus. Third, it acts as a moisture bank to help keep plants from withering in heat. Fourth, it serves as a trellis for vines. Fifth, it increases yield—all in about 20 sq. ft.

Six 18x48-inch panels, compost flakes, organic fertilizer and manual cost \$42.95 postpaid, from the Ringer Corp., 6860 Cloud Dr., Eden Prairie, Minn. 55344.—J.P.



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This exclusive new fast-chargin' cordless drill and screwdriver comes loaded with power and features to blast through big jobs.



Powered for the professional! Made tough, for the pro who uses a drill more than any other tool. Made powerful, to work long, hard hours every day—and recharge in just one hour. Made with features like variable speed and reverse, for driving and removing screws and tough drilling jobs.

Skil's Boar Gun Model 2016 drill/screwdriver has Dual-Torque: two powerful gear ranges that maximize power at the chuck.

"High" delivers 0 to 750 rpm for high speed drilling;

"Low" provides 0 to 250 rpm at high torque, for tough drilling and driving applications.

Boar Gun drill/screwdriver recharges in just one hour, thanks to Skil's remarkably efficient Power Paks. With a pair, you'll be able to rotate 'em and drill all day—with no delay. Plus, each Power Pak can be recharged up to 1,000 times before you replace their long-life batteries!

See Skil's 3/8th-inch Boar Gun Model 2016 drill/screwdriver with Dual-Torque (mfgs. sugg. retail: \$99.95), and models 2008 and 2012, with single torque ranges (mfgs. sugg. retail: \$89.95), at your participating Skil dealer. All models include one Power Pak and charging unit. Now you can do it with Skil—and save. With the tool it took Skil to build: Boar Gun Cordless drill and screwdriver!

Do it with **SKIL**.

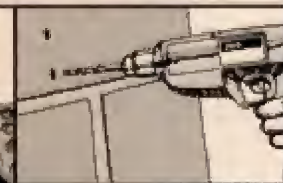
WORKS ANYWHERE, WITH POWER TO SPARE



Power to drill hundreds of holes in hardwood. Variable speed and reverse.



Drills in metal. Variable speed for tough screwdriving.



Even drills in tough masonry.



# CAR CLINIC

## SOLUTIONS FOR MECHANICAL HEADACHES

BY  
MORT SCHULTZ



### Positive reaction

*I have a 1976 Ford E150 van that's equipped with a positraction rear. A dealer told me that changing the lubricant in the rear involves pulling the rear axle. This would cost \$90 to \$120. Is the dealer right?—Joe Galvin Jr., Taylor, Mich.*

Yes. To drain the fluid from the Ford positraction, you have to remove the two rear wheels, pull both axles from the differential carrier, remove the driveshaft, remove the bolts and nuts holding the carrier assembly to the housing and slip the carrier assembly forward. Fluid will then drain.

Now, let me ask you a question: Why change fluid? Ford doesn't recommend that this be done unless fluid has been contaminated by water.

I hope you aren't confusing the positraction on your van with the one on the E250, which is a Dana axle. The Dana axle should be drained every 5000 miles if the vehicle is operated under severe conditions or is used for towing. But there's a provision made on the E250 to ease the job of draining. Just remove the axle rear plate.

### Well, shut my mouth

*Regarding the inquiry of Sam Nasca in the February Car Clinic: It is doubtful that the problem with his GM auto key is caused by a "burr" unless, of course, the key is being used for opening paint cans. When a key is hard to turn, especially a GM key, it's probably been made at a hardware or drug store.*

*If it does not happen to be an original GM key or an accurate duplicate made by a locksmith, it should be thrown away. If the key Sam has is an original or an accurate duplicate, then it may be worn excessively. In any event, a locksmith can make a new "original" from the improperly made or worn key.—Russell W. Rackliffe, Rackliffe Lock & Safe, Westbrook, Conn.*

I hate to say it, but thanks for locking this up for us, Russ.

### Pop goes the grommet

*I have a problem with the shift linkage of my 1979 Dodge Omni (manual transmission). On five separate occasions, something popped out and the shift stick became completely loose. Whatever gear the transmission was engaged in was the gear the transmission stayed in. The dealer blames bad grommets at the pivot points and says he can't make repairs that will last more than several thousand miles. Help.—Ernst Steinert, Peoria, Ill.*

Grommets it is, but there's some new information outlined in service bulletin 21-21-79 that your dealer may not be aware of. His parts books list two grommets.

When he sets about replacing a damaged grommet at the forward end of the shift tube, he must use the grommet having part No. 3467791. It is green. The other one (part No. 5211845) has a natural color. It, or the green one, can be used at other pivot points.

Installing grommets properly is important. Before installing a new grommet, inspect the hole from which the old grommet is taken. Clean off burrs, but be careful not to enlarge the hole. Apply a thin layer of grease to the inside of the new

grommet so the shift tube can be inserted easily. Grease also reduces friction as the tube shifts.

Incidentally, the problem and repair apply to 1978, as well as 1979 model Omnis and Horizons.

### A problem is born

*Nine months after buying a 1977 Pontiac Sunbird (151-cu.-in. engine), the gasket connecting the exhaust pipe to the engine started leaking. It was fixed, under warranty. Ten months later, same thing. Again, it was fixed. This time the service manager told me there had been many complaints like mine, and that gaskets were defective.*

Six months later, another leak. This time I'm told I have to pay for the repair, which is totally unfair since the trouble wasn't fixed correctly to begin with. Besides, why should the consumer have to pay for an inherent defect?—Jerry Homola, Lorain, Ohio.

Good question, Jerry. You shouldn't, and I don't think Pontiac expects you to. Tell the dealer to call a factory representative and have him judge the case. When the repair is made this time, it should be permanent. Pontiac has come up with a new repair procedure, issued in Sept. 1978, for the '77 and '78 Sunbirds. Tell your dealer to check his repair literature file for details.

The repair involves a newly designed exhaust manifold-to-head gasket (part No. 10000187), and the following repair technique:

1. Make sure all surfaces are clean.
2. Make sure the intake and exhaust manifolds are in the same plane. If they aren't, separate and reassemble them.
3. If leakage has been going on for some time, as it has in your case, the

*(Please turn to page 64)*

### Rub out

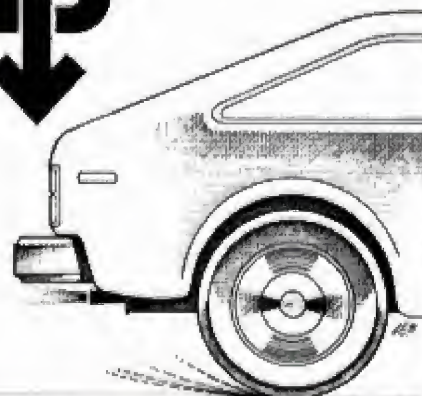
If you think that all of what is said about jackrabbit starts ruining tires is hogwash, listen to this.

According to Tom Ford, who is manager of radial tire engineering at Goodyear, "In tests, our radials are run 60,000 miles and more, when vehicles and tires are maintained correctly."

However, in a single wheel-spinning acceleration maneuver, a car owner can wipe as much as 1000 miles of useful tread life off a tire.

To those of you out there who still insist on making quick, screeching getaways, I say, "It's your money, pal."

1PM CAR CARE



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START LEAVES 1000 MILES  
OF RUBBER ON THE ROAD



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Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.





## CAR CLINIC

(Continued from page 62)

exhaust manifold may have warped. If so, replace it. Also replace the EFE (Early Fuel Evaporation) insulator.

4. Make sure all fasteners are tightened to the torque specifications given in the service manual.

### Runaway rumor

*Did you know that 1977-78 VWs are prone to run away, and there's nothing you can do to shut them off? Well, VW does and it's not telling anybody. People have been hurt, so I hope this saves someone.—Anonymous*

It isn't 1977-78 VWs that are involved. It's 1975-78 Rabbit and Scirocco models with standard transmissions. The problem arises in those cars with radios because of improper sealing of the hole in the fender apron through which the antenna cable is routed. Water splashed by the front tire can enter the car through this hole, trickle down the antenna cable and enter the fuse relay board. This could result in the starter being activated, which may cause the vehicle to move if the transmission is in gear and the parking brake isn't engaged. The

water might also cause short circuits that could lead to fires.

The company announced a recall last May. The repair involves sealing radio antenna cable holes and replacing fuse relay boards that are corroded. According to the National Highway Traffic Safety Administration, three related accidents have been reported, but no injuries.

### Boiling over oiling

*Pasted on the inside cover of my 1979 Mercury Capri owner guide is an oil usage caution which reads as follows:*

*"To give your engine the best protection against wear, use only oils with the API marking on the container of SE, SE-SD, SE-SD-SC or SF where available. DO NOT use any oil showing CC or CD on the container, including SE-CC or SE-CD. This information supersedes the oil usage information contained in the Owner Guide."*

*Most major brands of multigrade oils are marked SE-CC or SE-CD. Furthermore, my dealer and the Ford Motor Co. regional office say that these oils won't harm the engine. Who's right? Who's wrong? What gives?—Alfred Thompson, address not given.*

## Jam session

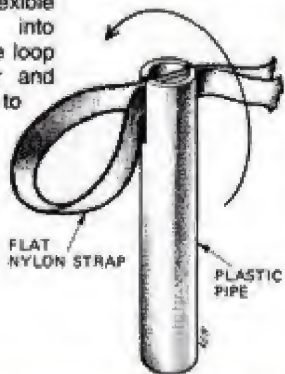
PM CAR CARE



If access to the oil filter on your Omni or Horizon has been a problem, Maj. John E. Mertz III of Kirtland AFB, N.M., can help.

Maj. Mertz says, "As you know, the oil filter of the Dodge Omni is jammed between the radiator and engine block. So wouldn't you know it—when the dealer did the first oil change, oil was leaking from around the filter when I got the car back, because the dealer couldn't get the filter tight enough."

"I have two types of oil-filter wrenches, but couldn't get either of them into the confined space, because the bands are too wide. Well, I solved the problem. I cut slits into the sides at the top of a one-foot-long piece of 1½-inch scrap plastic drain pipe and jammed a loop of flat, flexible nylon strap into them. I slip the loop over the filter and twist the pipe to get the strap tight. This allows me to tighten and loosen the filter easily."



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Available in pump or aerosol.

"What gives" is confusion, because too many people, like your dealer and regional office, are putting in their 2 cents' worth. According to Ford Motor Co. in Dearborn, Mich., cars built with 2.3-liter, four-cylinder engines from 1974 through 1980 should absolutely not be fed any oil that is rated for CC or CD use.

Originally, the recommendation resulted when it was found that premature camshaft rocker-arm wear was occurring in 2.3-liter engines in models from 1974 to early 1978. The trouble stems from the fact that some oils don't possess sufficient zinc to compensate for the high load of the valve springs, and the fact that the rocker arms are coated with phosphate.

In fact, this is a whole mishmash of chemistry I don't want to get into, but I do want to emphasize that Ford is extremely concerned about the oil you should and should not use in your vehicle.

According to engineers I spoke with at Ford, there was a change in valve-spring loading beginning with late '78 models, and the phosphate coating has been removed from the rocker arms. Still and all, oil rated CC or CD is not to be used in the 2.3-

liter engine since, Ford feels, it doesn't "provide sufficient wear resistance."

As for your statement that "most major brands of multigrade oils are marked SE-CC or SE-CD," I haven't counted them, so I can't really say for sure.

However, in service bulletin 195 (10/31/79), Ford lists over 200 different oils which have been tested and found suitable for use in the 2.3-liter engine. Every Ford and Mercury owner who doesn't know which oil to use should ask a dealer to consult this service bulletin.

I'll let you in on something else. A new generation of oil (API classification SF) is supposed to be introduced this year.

It supposedly will offer better wear protection and oxidation stability than current oils do. When new SF comes on the scene, Ford will recommend that cars and trucks, no matter what engines they have, switch to it.

### GOT A PROBLEM WITH YOUR CAR?

Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. While letters cannot be answered individually, problems that are of general interest will be published in the column.

## Safety and service tips

■ In case you haven't heard, Datsun has recalled 1975-1979 280Z models and 1977-79 810 models so that their dealers can correct a defect that could be a safety hazard during cold weather.

Low temperature coupled with high humidity produced by the blowby ventilation system may cause a sticking throttle condition that results in a prolonged high idle. This could be dangerous on snow- or ice-covered roads. So right now, during warm weather, is a good time to have the repair done. Some 295,710 cars are involved.

■ If the aluminum airconditioning compressor mounting brackets in your 1980 Horizon or Omni have cracked, turn them in for new steel brackets, Chrysler says. Service bulletin 24-02-80 authorizes your dealer to make the change. Two brackets are involved: front and rear.

■ If the hood on your 1979 Jeep Wagoneer, Cherokee or truck binds, here's a simple way to stop the trouble.

Start by removing the hood release (it's held by a single shoulder bolt). Lubricate the shoulder bolt. Place a flat washer and a nylon washer on the upper side of the hood release, and a wave washer on the bottom side of the release. Reattach the release. Drill a new spring anchor hole 1/4-inch (center to center) outboard of the old hole ... that's to the left of the old hole as you face the vehicle. Now attach the spring.

PM





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velocity, compared with 1200 to 1300 for the high-velocity, long-rifle hollowpoint. Energy jumps 42 percent from 142 foot-pounds for the high-speed, long-rifle slug to 202 foot-pounds for the Stinger. The lighter bullet is moving faster and the basic law of physics applies—kinetic energy increases with the square of the velocity.

The bullet is different, as well as lighter, and is made by a completely new process. As with all commercially loaded lead bullets, the slug is formed by swaging rather than casting, squeezed to size and shape like toothpaste. To prevent barrel leading and explosive breakup on impact, the hollowpoint bullet is electroplated with a copper jacket. To achieve controlled expansion, the jacket is die-cut into what CCI calls a Pentapoint.

#### Other entries

Shortly before CCI's Stinger, Winchester produced the Dynapoint, a high-velocity, long-rifle cartridge with a tiny dimple in the nose, giving greatly improved effectiveness on varmints. Then Winchester came up with its own hypervelocity .22, the Xpediter. It puts out a 29-grain, Lubaloy-copper-coated hollowpoint at 1680-f.p.s. muzzle velocity and 182-foot-pound muzzle energy.

Now Remington has come along with the Yellow Jacket, with a 33-grain, truncated-cone, hollowpoint bullet at 1500 f.p.s. The slightly heavier, slower bullet has 165 foot-pound of impact energy. Any of these potent pest eliminators cost about 50 cents more a box and give an inch or smaller target groups at 25 yards from guns that like them.

#### Specialties

While the new hot cartridges grab the limelight, .22 shorts and long rifles by Winchester, Remington, CCI and Federal are still the biggest sellers. Shorts produce almost the same energy at 25 yards that long rifles do at 100, and are quieter. Gallery loads with frangible bullets that break up into lead dust on impact are even quieter and cheaper. Old-time BB and CB caps are again available, and are good for informal target shooting with a suitable backstop. In an effort to create .22 shotgunning for back-yard trap and skeet with junior-size clay birds, long-rifle loads with No. 12 birdshot were introduced and, known as snake loads, are still available.

With prices of everything going up, .22s are still the cheapest way to enjoy shooting.

PM

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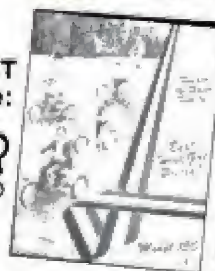


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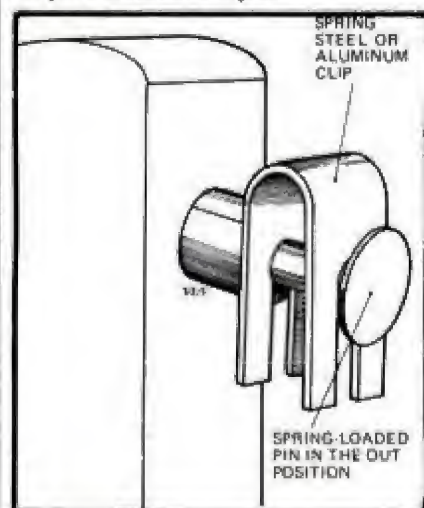
## HINTS FROM READERS

### Corner braces aid gluing



When I have to glue two pieces of wood together at a right angle, I use a pair of perfectly square corner braces—without screws—to serve as a jig for keeping the setup at 90°. Hold wood and braces together using either C- or spring clamps as shown.—*Walter E. Burton*

### Clip holds index pin



Holding a spring-loaded index pin in the out position is tiresome and occupies one hand. This occurs in machine-shop work when metal is bent on a brake, or die sets are used to locate pins for blanking. To avoid this, bend a clip of aluminum or spring steel and groove the ends to fit over the pin's shank. Heat spring steel (not aluminum) with a propane torch; hammer it to shape in a vise and hacksaw the grooves.—*Edward Mayover*

### Protect stored woollens

Protect mittens and other small woolen items during the summer by storing them in sealed sandwich bags that contain a few moth flakes.—*Lane Olinghouse*





# NOW FOR \$75. THE WATCH THAT REPLACES EVERYTHING.

Introducing Casio's newest, the C-80 Calculator Chronograph. A watch that figures to replace a lot of other watches. And calculators. And stopwatches.

In fact, it even replaces the age-old myth that a timepiece loaded with talent has to be expensive.

The Casio C-80 is priced at only \$75.

## A calculator made for real fingers.

Here's the first calculator chronograph that can be operated easily with your fingertips. No need to use a stylus or pen; the keys are far enough apart that even the broadest fingers can work them.

Now you can add, subtract, multiply, divide—perform chain calculations up to six places, plus decimal. Numbers appear in crisp liquid crystal digits. There's even an indicator that tells you exactly which function is being performed.

## Stopwatch, 2 time zones—and more.

The push of a button turns your calculator into a fiercely talented stopwatch. You get  $\frac{1}{100}$  of a second accuracy, lap times, and up to 59.59 minutes of track-style timekeeping. Timing automatically starts over after the hour.

You also get two time zones; the second zone can be set for 12 or 24-hour time (especially useful for frequent travelers). Hours, minutes and seconds are displayed with reliable  $\pm 15$  second-a-month quartz precision. AM/PM indicator is always visible.

Press another button, day of the

week and date appear. And another for built-in night light.

## Feather-light, yet rugged.

The 1 oz. case and band are constructed of high impact black plastic. And so lightweight and comfortable, you may not realize that on your wrist you're wearing—among other things—a clever calculator.

Other companies have tried introducing similar watches, only using bulky stainless steel. These steel

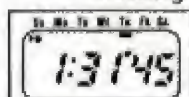
mechanical parts to wear out or break. A tough mineral glass crystal prevents scratching. And the tightly fitted case and crystal provide water resistance for everyday use.

## Reserve yours now.

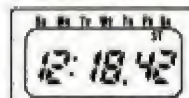
You might wonder why you haven't seen this superb chronograph in the stores. The fact is, it isn't going to be in any stores—not for a while.

However, beginning late March 1980, The Sharper Image will be the first people anywhere to take delivery on these exciting Casios. And you can reserve yours now. But please order immediately to be assured of earliest delivery. As quantity is limited, orders will be handled on a first come, first served basis.

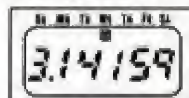
And as always, The Sharper Image guarantees your satisfaction. If not delighted with your new Casio, simply return it within two weeks for a full and courteous refund. One-year manufacturer's warranty and 15-month (normal use) battery included.



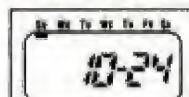
Normal Time Display: hrs./mins./secs. AM/PM, Day and 2 time zones.



Stopwatch Display: 1/100 sec. timing. Auto start-over at 1 hr. Lap times.



Calculator Display: add, subtract, multiply, divide—to 6 places with decimal.



Calendar Display: day/date. Auto end of month adjustment.



versions sacrifice the comfort, lightness, and handsome appearance provided by the latest advanced plastics.

What's more, this Casio chronograph is built incredibly rugged to provide years of reliable service. There are no

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## PM LOOKS AT A NEW WAY TO FASTEN

**C**ontrary to its name, the Rad Fastener Kit has no fasteners—it contains an assortment of thermoplastic rods and nut blanks. When you want a special fastener, you can shape one in seconds.

A significant property of the thermoplastic material is that it expands (inside diameter decreases) and shrinks in length when heated. If you have a screw but lack a matching nut, all you do is slip a nut blank over the thread-

ed metal screw or bolt. Then you heat the nut blank until it expands and forms threads.

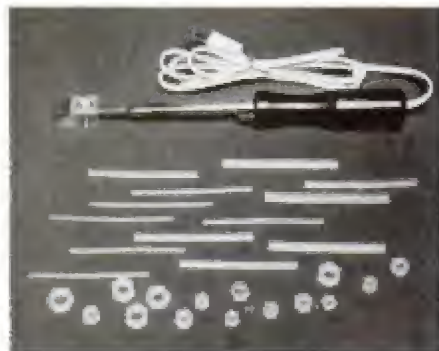
You reverse the procedure to make a screw when only the metal nut is available. Insert a rod blank into the nut and heat the rod. To form a screwhead, press a screwdriver into the heated plastic.

To make a rivet, apply a heated piece of metal to the end of a rod and shape the head. Form the second head after you have inserted

the rivet into the parts to be joined.

You can apply heat using the open flame of a match, a soldering iron, a heat gun or the special heating iron that is available from the kit makers.

The kit containing rods and nut blanks is priced at \$4.95 postpaid. The deluxe kit, which includes the heating iron, is \$14.95 postpaid, from Gama Scientific, Box 351, Chalmers Blvd., Amawalk, N.Y. 10501.—*Rosario Capotosto*



The kit contains an assortment of thermoplastic rods and nut blanks. Purchase of the heating iron is optional.



Use the heating tool to form rivet and screwheads. Fasteners of this tough plastic have good holding power.



Heat from a match quickly expands the thermoplastic material so that it takes the impression of the bolt threads.

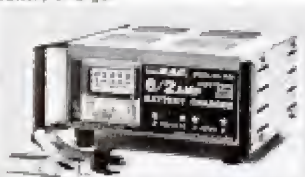
## Declare your independence with RAC products.

"Dial-A-Pressure" Air Foot Pump



Finding it increasingly difficult to get your car or van properly serviced and maintained? With an ever increasing number of gasoline stations converting to self-service and drastically reducing their hours, it's

Battery Charger



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no surprise if you are. So why not take matters into your own hands? That's right... do it yourself and do it right with the help of RAC's high quality Test and Tune-Up Equipment. RAC products are all designed with you in mind: extra simple to use for the first-timer, carefully calibrated and ruggedly constructed to meet the exacting standards of the experienced do-it-yourselfer. And the

RAC quality products guarantee that it is still safe, easy and economical to tune your own car.

Maxi-Tune Ignition Analyzer



550

Timing Light



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surprise bonus is that RAC products, widely recognized as the standard for the industry, cost no more — often less — than competing products. So declare your independence today from inconvenience and escalating maintenance costs with RAC Test and Tune-Up Equipment.

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# How the ~~X@!\*~~ do they expect us to put out a volcano?

11:30 PM, April 13th, 1979. After five exhausting days fighting a fire aboard a ship in St. Thomas Harbor, The Coast Guard cutter, GALLATIN was slicing through Caribbean waters bound for New York and home. Charles E. Monsen, Quartermaster Third Class, was asleep in his bunk when a voice blared over the P.A. System.

"Attention all hands. The volcano on St. Vincent Island is erupting. We're now changing course and heading due south..."

He woke up wondering if he was dreaming. "Volcano? How the #\$%¢ do they expect us to put out a volcano?"

It was no dream. Within two hours, the GALLATIN was a mile and a half from the exploding crater, serving as a rescue coordinator for all forces.

As the booming volcano spewed its searing ash all over the countryside, Charles Monsen and his crewmates kept air and ground evacuation crews mobilized through radio contact.



"Hello, copter, do you hear me?"

"Yes...we just flew over the crater...it's unbelievable...all this boiling, frothing mud...like looking into a live generator..."

It wasn't until five days later, when the volcano finally quieted, that Monsen had a chance to think about his experience—"It was one of those things very few people see in a lifetime. Awesome!" And about the Coast Guard—"It feels good to be doing something useful."

We think he summed it up pretty well. Being useful, protec-

ting lives and property, helping others—that's what the Coast Guard is all about. And when it comes to helping yourself, there are a lot of great jobs in the Coast Guard. In fields like electronics, mechanics, navigation, aviation, communications and seamanship. And the Coast Guard gives you all the training you need to get your career off the ground.

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THE COAST GUARD.**







# "I wish I'd known about NRI when I was learning auto mechanics."

## **Says Richard Petty, America's Winningest Stock Car Driver and NRI Automotive Consultant**

Even with my Daddy's help, I made a lot of mistakes and wasted a lot of time I could have used today. If I'd had NRI training in auto servicing, I tell you, I'd of learned a lot faster.

## **NRI Gives You the Training and Equipment You Need to Get Started in a Hurry**

There's always plenty of work for a good mechanic. And NRI's training gets you right into it. You get easy-to-understand, "bite-size" lessons with plenty of clear pictures and diagrams. And you get professional tools and instruments you keep to use in your work. NRI calls it "hands-on" training, and I've never seen better.

## **Learn at Home in Your Spare Time**

The NRI people understand what it means to have to earn a living or support a family. So they teach you right at home. You can put your weekends or evenings to profitable use without quitting your job or going to classes. It's a terrific way to increase your skills or start a whole new career.



NRI training includes professional instruments and tools.

## **Take Your Choice of Two Courses**

The good part is, you can tailor your training to your needs. NRI's Basic Course concentrates on the big tune-up field. You also get training in brake work and other basic systems with 30 lessons and all the equipment you'll need. It includes an inductive pickup timing light, ignition analysis and tune-up instrument, tune-up and brake servicing tools, useful maintenance tools, and lots more.

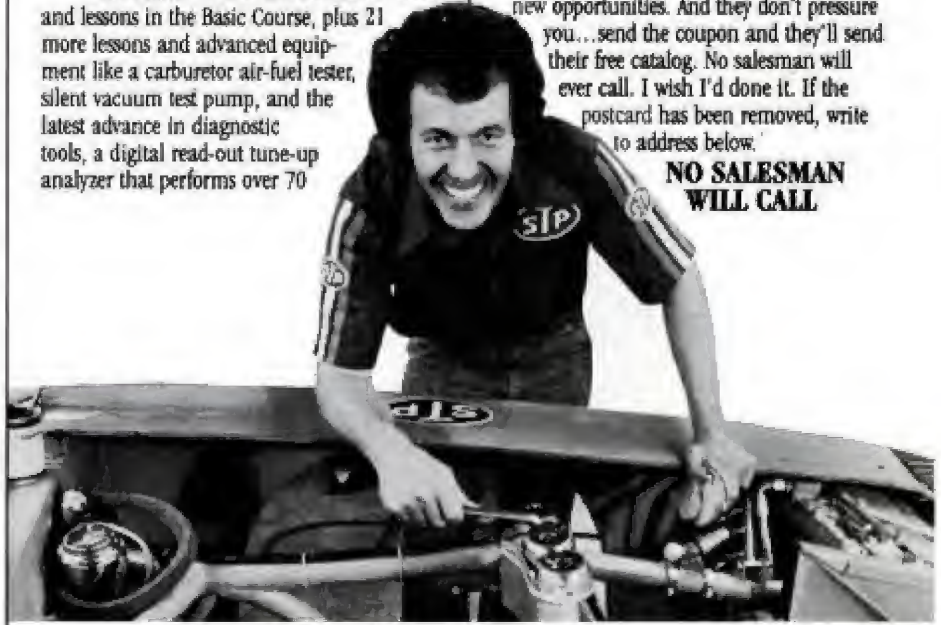
The Master Course includes all the tools and lessons in the Basic Course, plus 21 more lessons and advanced equipment like a carburetor air-fuel tester, silent vacuum test pump, and the latest advance in diagnostic tools, a digital read-out tune-up analyzer that performs over 70

tests. You learn to service engines, suspension systems, front ends, transmissions, electronic ignitions, heaters, air conditioners, take care of a car from bumper to bumper. You're ready to step up to a good job or spare time money with training like this.

## **I Know It Works**

NRI has been in the business of training people at home for more than 60 years. They've enrolled over a million students, started them on their way to higher pay and new opportunities. And they don't pressure you...send the coupon and they'll send their free catalog. No salesman will ever call. I wish I'd done it. If the postcard has been removed, write to address below.

**NO SALESMAN  
WILL CALL**



## **Or check out these other growing fields.**

### **Small Engine Repair**

There's plenty of opportunity for the man who can service lawnmowers, garden tractors, chain saws, tillers, outboards, mopeds, motorcycles and other small engines. NRI training includes professional tools...inductive tachometer, volt-ohm meter, torque wrench, valve spring and ring compressors and more. In our Master Course, you actually build a 3 1/2 HP engine as part of your training. Check postcard for catalog.

### **Air Conditioning/ Refrigeration/Heating with Solar Technology**

Gets you into a wide-open, fast-growing area with practical training that includes lessons on solar heating, heat pumps, etc. Complete with professional tools, including

professional vacuum pump for purging systems. Master Course includes optional post-graduate training at York Institute Resident School at no extra charge. Check card for catalog.

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Good appliance repairman are hard to come by. NRI trains you for your own full- or part-time business in fixing everything from mixers to microwave ovens...to refrigerators and freezers. Step-by-step training includes professional instruments and tools for learning and earning. Check card for catalog.



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# Now: TV with true high-fidelity sound

At last you can buy a TV with high-fidelity sound. The manufacturers' new models offer better speakers and improved audio amplifiers.

by Stan Prentiss



Large, well-placed speakers and improved audio amplifiers characterize new sound-conscious TV, such as Sylvania's Super Sound series models.



**S**till far from rock 'n roll percussion, television audio has been improved in top-of-the line table models. Certain deluxe 25-inch models have up to 12 watts output, with creditable distortion figures and specially mounted speakers in better-than-average enclosures. Manufacturers leading the parade are Zenith, Magnavox and Sylvania, followed by RCA with dual sound.

None of this is stereo yet, but that's on the way, as Electronic Industries Assn. panels and the Federal Communications Commission (momentarily an observer) prepare to study various stereo transmission and receiving systems before reaching final conclusions and legal judgments.

System testing should begin this summer, and TV's stereo time could come as early as late 1980 or early 1981. Japan is already broadcasting TV in stereo; it's popular for broadcasting baseball—and there's no

reason football, swimming, track or boxing couldn't profit equally by the stereo effect of an audience reacting to the participants. Meanwhile, Europe is most interested in the medium, since two languages could be "simulcast" together, thereby solving the ever-present problem of international translation.

Whatever the ultimate use, TV sound-stereo, probably preceded by stereo AM radio and FM quadraphonic sound, is most assuredly on its way.

## What sounds good now?

In the meantime, we're looking at pretty good monophonic music and speech reproduction for TV—much better than in the past—even though only 25-inch, expensive consoles have the really worthwhile amplifying systems. Interestingly enough, most of the high outputs were originally designed for radio, rather than TV, and have been add-

ed to this year's models for a sort of dry run. If big sound catches on, expect many more improvements in the future, probably with prices to match.

Now, here's what's on the market today . . .

## Magnavox

Big Voice Magnavox has reworked its entire 19- and 25-inch color television models for increased audio power. It has added voice/music controls in all 25-inch touch-tune and "star" remote-control system sets (except 5054/5056) and a tone control for all 25-inch one-knob electronically tuned receivers. In models 5054 and 5056 Magnavox has installed a new 12-watt amplifier with separate bass and treble controls, driving a three-way speaker system with frequency response from 75 Hz to 15 kHz.

Magnavox further announces new

*(Please turn to page 80)*





**4x4**

# INTRODUCING THE DATSUN OF 4-WHEEL DRIVE



Grab your gear — the first 4x4s by Datsun are here! With the biggest choice of compact 4-wheel drive truck bodies in America.

**TOUGH IN THE ROUGH, SMOOTH ON THE ROAD**  
Datsun takes 4-wheel drive where the competition's never been. With the highest minimum ground clearance in the class. Solid steel plates to protect underbody parts. A powerful overhead cam engine. A separate high/low range 4x4 transfer stick. And enough built-in tough to tame the roughest road.

But there's plenty of beauty in the beast, too. The new Datsun 4x4s have independent front suspension and big 15-inch wheels to glide you in road-smoothing comfort.

**ROOMIEST COMPACT 4-WHEELER IN HISTORY**  
The Datsun King Cab 4x4 has over 7.1 cubic feet of inside storage space — and optional jump seats inside! Now check out the standards: reclining buckets, tachometer, trip odometer, flip-out rear side windows, flip-down cargo light and the only standard 5-speed in the class. No 4x4 can treat you more like a king!

And if you're looking for a long bed, Datsun's the longest in the class with over 7 feet of cargo length.

**REMINDER: BE GOOD TO YOUR LAND**  
Rugged as the new Datsun 4x4s are, it's important to respect the natural beauty of our wilderness land. Use 'em on the off-road roads, and in designated rec vehicle areas. That'll keep us all truckin' for a long time to come.  
Visit your Datsun dealer, and test drive the hottest 4 wheels in America today — the 4x4s by Datsun!

**DATSUN**  
WE ARE DRIVEN

Some items shown are owner-installed custom options.





# NEW WRANGLER

## The all-season light truck tire



**The advantages of a mud-snow tire, without the inconvenience.** Until now, light truck owners needed one set of tires for normal driving and another set for snow or mud. Goodyear's new Wrangler All-Season Radial eliminates your need for those two sets of tires. Its rubber compound and open aggressive tread give Wrangler All-Season Radial the traction characteristics of a mud-snow tire. And eliminate your need for winter tire changeover.

**The new way to cover all kinds of ground.** Wrangler All-Season Radial also eliminates your need for one set of tires for on-road driving and another set for off-road driving. Being all-terrain, as well as all-season, Wrangler All-Season Radial admirably meets both sets of driving requirements.

**The one tire for all four wheels.** Between traction and ease of handling, Wrangler All-Season Radial has a terrific balance of performance. That means you can put this new tire at all four wheels, for added front traction in ice and snow.





# WRANGLER RADIAL

## built for almost any terrain.

**Surprisingly less road noise.** You'd expect the open tread of the Wrangler All-Season Radial to generate considerable road noise. But Goodyear engineers have used a computer program to design a tread that rides quietly, quieter even than some regular highway tires.



**The light truck tire that does it all.** Put your truck on the new tire built for almost any weather and terrain. Ask for the new Wrangler All-Season Radial at your Goodyear dealer or store.

**GOODYEAR**

Out front. Pulling away.





## HIGH-FIDELITY TV SOUND

(Continued from page 76)

speaker systems to 12 kHz in some 19-inch sets, extended-range 4x6-inch speakers in the deluxe 19-inch models with response improvement from 9 kHz to 14 kHz. Other receivers which formerly had 6x9-inch speakers now have higher quality two-way speaker systems, along with six-inch woofers and three-inch tweeters, improving sound response to a full 15 kHz.

How and why all these audio changes came about, Magnavox explains, is because in January 1978 American Telephone and Telegraph (AT&T) instituted new methods of transmitting video and audio by way of high-frequency microwaves, extending TV sound limits from 5 kHz to 15 kHz.

And Magnavox, as well as the other manufacturers, has taken advan-

## Zenith

Zenith merely adapted some of its stereo Wedge system, in the form of a power amplifier and inserted two pairs of tweeters and woofers, all connected to the 10-watt power amplifier. This is controlled by bass, treble, music/speech switches and volume up/down buttons on the front panel, or simply up/down buttons on the Space Command remote. In the "speech" mode, shunt capacitance adds some resonance that's pleasing to the ear and should filter annoying "highs" resulting from noise. The "music" position, of course, permits standard resistance/capacitance coupling in the tone control portion.

Zenith specifies power output at 10 watts, with less than five percent Total Harmonic Distortion (THD) and frequency response to 10 kHz. Models having this large power output are: SL2561, SL2571, SL2575

and have suggested list prices of \$779.95.

Models containing this deluxe sound are: CL9256P, CL9253C and CL9251P—all of which also feature GT-Matic color, automatic sharpness control, Dark-Lite picture tube, electronic tuning, and room light monitor. Sets are 25-inch consoles



Quasar WL9556RK features lifelike audio.

and have suggested list prices of \$779.95.

Cabinets feature crafted veneers, hardwoods, and simulated wood. Picture color is very good. All receivers have large-board, removable panels and are quite home-serviceable.

## Quasar

Quasar also features "Audio Spectrum Sound" through a specially designed, electronic coupling network to a 3.5-inch tweeter, a 4-inch mid-range speaker, and lows into a 5x7-inch woofer for lifelike audio out of the cabinet on either side of the cathode ray (picture) tube.

Nineteen-inch models in this group are: WT5982QW, TT5988QW and TT5989RW. Twenty-five-inch consoles having Audio Spectrum Sound are: WL955ORK, WL9554RS, WL9556RK, TL998ORP, TL9983RK and TL9984RS.

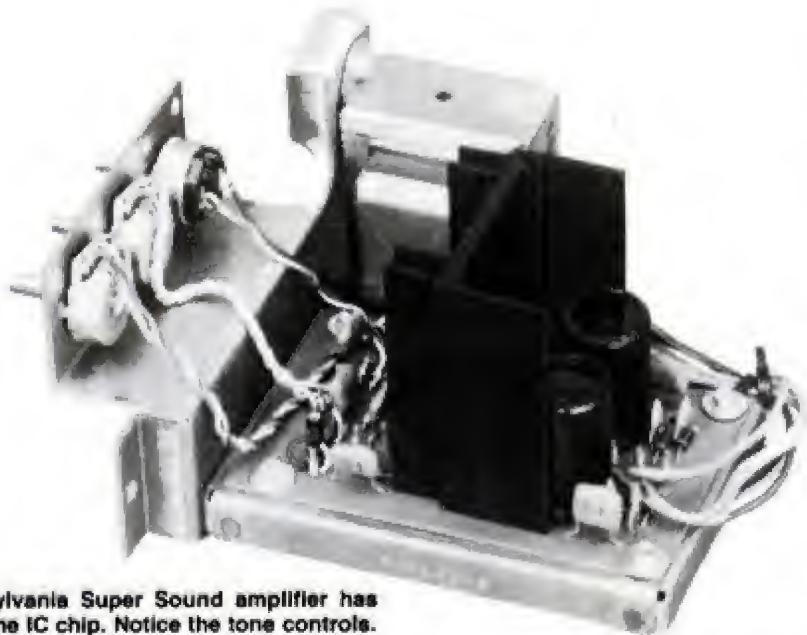
Quasar also features a 100 percent DynaModule III chassis, in-line picture tubes, many remote control versions, Glare Guard picture tube filter and some very attractive cabinets.

## RCA

While not yet in the big-power, 8- to 12-watts-output race, big RCA has opted for a dual-sound system that isn't stereo, but has much the same effect as re-recording some of the old records, such as famous jazz works, to make them sound better and more distinct.

In this particular system, audio is divided into five parts—low to high—with medium lows and medium highs into one speaker and the rest into another. Circuits are built around an operational amplifier and

(Please turn to page 82)



The Sylvania Super Sound amplifier has only one IC chip. Notice the tone controls.

tage of these extended frequencies to provide obviously better TV sound.

Nineteen-inch models include: 4416, 4414, 4412, 4386, 4382, 4245, 4240, 4224, 4222, 4190, 4170 and 4168. Twenty-five-inch models are: 5076, 5068, 5056, 5054, 5034, 5032, 5038, 5036, 5020, 5010, 4836, 4834, 4818, 4816, 4814, 4812, 5270, 5256, 5254, 5226, 5210, 5476, 5466, 5460, 5426, 4736, 4734, 4716, 4714 and 4712.

Many of these receivers also feature comb filters for 25-percent better horizontal resolution, and micro-processor channel tuning for VHF/UHF and the eight midband CATV channels.

Their prices start at \$399.95, and go up to \$945. All sets are 100 percent modular.

and SL2577, all 25-inch, top-of-the-line consoles which have no suggested retail price. However, you can count on their being more than \$900. Color is exceptional and pictures are very good. Zenith's System III fully modular receivers are *completely* home serviceable.

## Sylvania

Sylvania has also emerged with a high-fidelity audio output system. Specifications are 8 watts RMS (min.) into 4 ohms from 40 Hz to 15 kHz, with 0.5 percent (max.) harmonic distortion. Three-inch tweeter and six-inch woofer are included, with the woofer matched to a tuned port enclosure. Separate cut/boost tone controls handle treble and bass response, and a high-filter switch re-



---

**Latest Wave Of Smoker Research:**  
**Smokers prefer MERIT 3 to 1 over high tar leaders**  
**in tests comparing taste and tar levels:**

---

# Merit Solid Winner!

**Smokers Report: MERIT  
Taste Matches High Tar Cigarettes.**

New taste tests with thousands of smokers prove it.

**Proof:** A significant majority of smokers rate MERIT taste as good as—or better than—leading high tar brands. Even cigarettes having twice the tar!

**Proof:** Of the 95% stating a preference, 3 out of 4 smokers chose the MERIT low tar/good taste combination over high tar leaders when tar levels were revealed.

**MERIT: Proven Long Term  
Alternative To High Tar Brands.**

New national smoker study results prove it.

**Proof:** The overwhelming majority

of MERIT smokers polled feel they didn't sacrifice taste in switching from high tar cigarettes.

**Proof:** 96% of MERIT smokers don't miss former high tar brands.

**Proof:** 9 out of 10 enjoy smoking as much since switching to MERIT, are glad they switched, and report MERIT is the best tasting low tar they've ever tried.

You've read the results. The conclusion is clearer than ever: MERIT delivers a winning combination of taste and low tar.

A combination that's attracting more and more smokers every day and—more importantly—satisfying them long term.



**MERIT**  
Kings & 100's

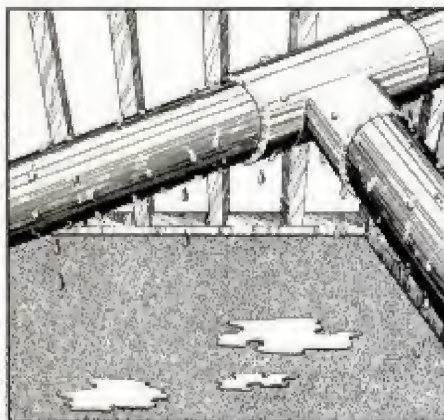
Warning: The Surgeon General Has Determined  
That Cigarette Smoking Is Dangerous to Your Health.

© Philip Morris Inc. 1980

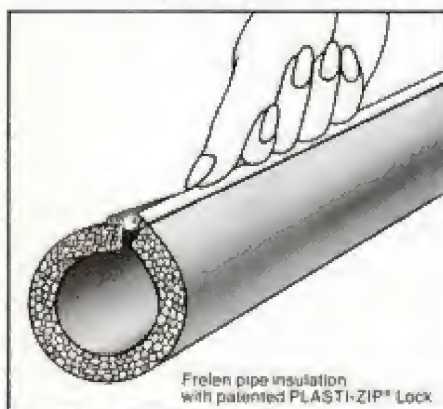
Kings: 8 mg "tar," 0.6 mg nicotine—  
100's: 11 mg "tar," 0.7 mg nicotine  
av. per cigarette, FTC Report May '78



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## HIGH-FIDELITY TV SOUND

(Continued from page 80)

all are placed on a soldered-in module.

This feature, along with Super AccuFilter 100° deflection angle picture tube, ColorTrak and Dynamic Detail Processor is contained in five top-of-the-line 930 series models. The suggested list prices are pegged at \$1149.95 each—all with Channel-Lock remote controls for set on/off, volume up/down, and channel number and time appearing on the cathode ray tube whenever sound or channel keys are pressed.

One stunning model is the GD930AR (all in silver), which commemorates the 25th anniversary of color television. Other sets in the newly introduced series are: GD930R, GD935R, GD936R and GD938R. The Dynamic Detail Processor is an analog/digital comb filter which precisely separates chro-



Magnavox 5020, one of 30 25-inch models.

ma and luminance, and permits a full 4-MHz horizontal line resolution at the picture tube—meaning an additional 25 percent better picture detail, just like Magnavox.

### When will stereo come in?

As for TV stereo, the wait isn't going to be exceptionally long, but there are problems along the way.

At the moment, at least two difficulties delay stereo TV introduction. One is the type of transmission system, and the other is the quantity of public pressure needed before the FCC begins to push actively for rule-making and legal authorization.

Some advocate the basic FM radio method, where a 38-kHz suppressed carrier with double sidebands delivers the usual 0 to 15-kHz stereo audio response that's contained with the allocated  $\pm 75$ -kHz FM deviation. The total ( $2 \times 75$  kHz) represents 150 kHz, the maximum deviation of any FM station.

TV sound, unfortunately, is permitted only  $\pm 25$  kHz, or 50-kHz deviation (amplitude swing). While this is only one-third of regular FM,

contrary to some beliefs, it will also permit full audio frequency response. However, it does restrict FM's dynamic range, inducing more noise in the receiver. So, in rather formal terms, the signal-to-noise ratio (S/N) for TV FM sound is not as



Zenith Showcase has high power output.

good as radio FM sound because of restricted deviation.

Naturally, the FCC could ignore the existing signal-to-noise difference and put stereo TV on the air anyway, using most existing transmitters with modest electronic additions. Then it could, as the Japanese do, double the TV receiver's horizontal sweep rate of 15,734 Hz, and use 31.47 kHz as the stereo subcarrier, avoiding the usual 19-kHz pilot transmission.

Finally, there's enough spread in the 6-MHz channel width permitted to increase FM deviation beyond the already existing 50 kHz. That, of course, would reduce some of the objectionable noise in the process.

TV stereo would mean better entertainment and novel uses of TV. In education, simulcasting two languages, one on each channel, is a natural for learning a second



Sylvania CX9174W is home-serviceable.

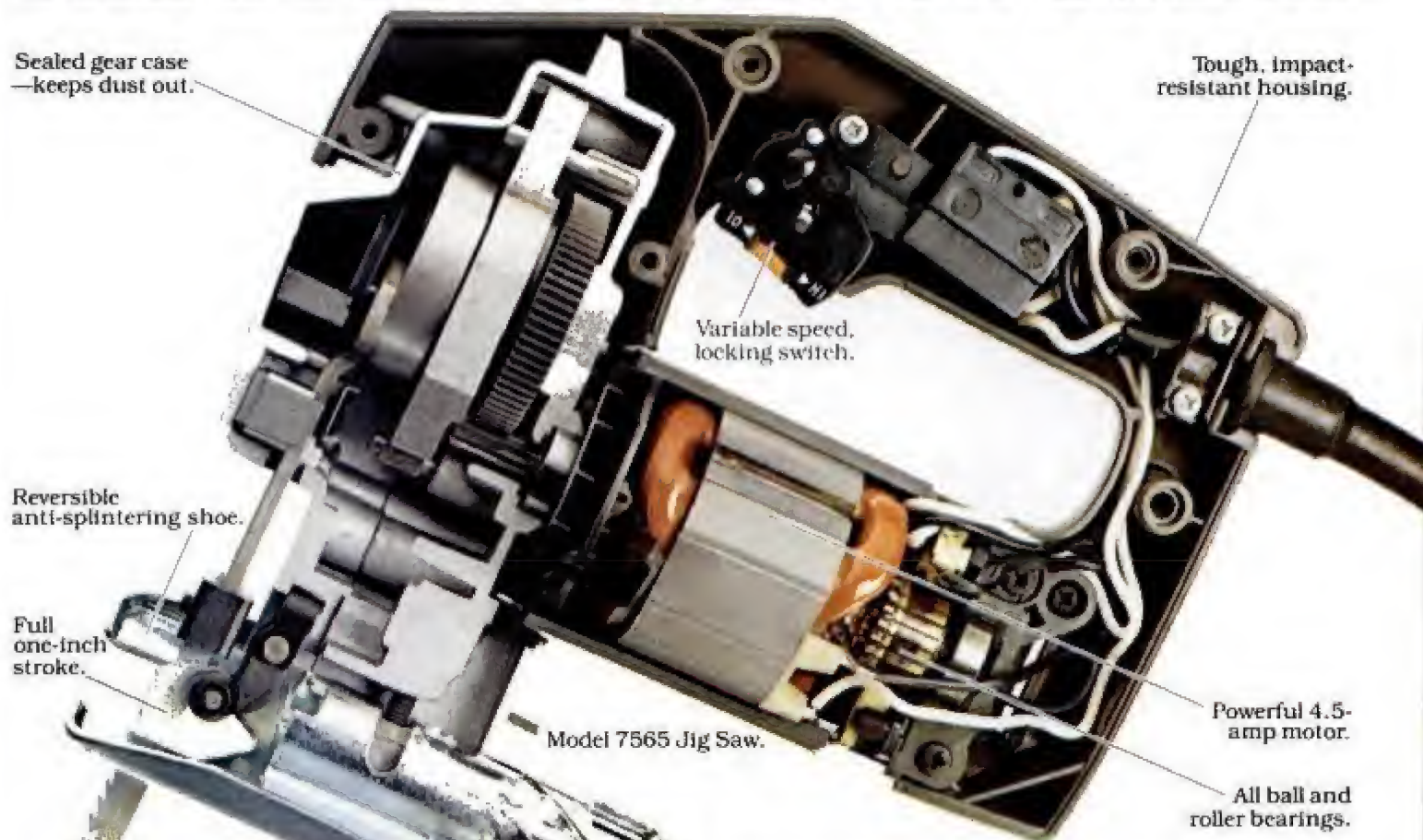
tongue. As videodiscs and cassettes offer stereo outputs, TV stereo will become more of a necessity. Digital sound requires good stereo.

In reality, dual-channel sound is virtually ready and waiting. It's up to you readers and the politicians to do the rest. How about TV stereo for Christmas 1980? It can become yours if pushed!

PM



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# PM WORKBENCH

## PM EXAMINES PRODUCTS & SERVICES

### Insulating crawl spaces

A question frequently asked by readers and friends is, "How do I install the insulation between joists in my crawl space? If I just staple the flanges won't it eventually fall down?" The answer is yes, it will, because staples alone simply aren't strong enough to hold horizontally installed insulation batts or blankets. The tried-and-true method according to the experts at Owens-Cor-



Wire mesh secures underfloor insulation.

ning Fiberglas is:

1. Wedge the insulation between the joists, with the vapor barrier facing the subflooring. Do not leave faced insulations exposed.

2. Install a wire mesh (as shown above) or crisscross wire over nails located in the joists' undersides, shoelace fashion. This will serve to keep insulation permanently in place.—H.W.

### Neater painting

Recently, I painted my kitchen with the Roll-O paint applicator, a combination roller-paint tray. The device works like a charm: Plastic rollers pick up paint from the reservoir and transfer it to the roller nap as you roll the tool on the wall. Misting was held to a minimum and the work went quickly, but cleanup takes slightly more time than cleaning a



Paint applicator has a built-in reservoir.

conventional roller and tray. It's \$10.70 postpaid and may be obtained from Sherwood Marketing, Dept. RLO-301, 180 Post Rd., East Westport, Conn. 06880.—J.P.

### Hammer with an accent

Called French Joiner's Hammer, this hammer is claimed to be preferred by continental woodworkers. The striking face and body of the head are forged square with a flat underside to provide a full striking surface. Weighing just 8 oz., its larger face is  $\frac{7}{8}$  in. square. I now use



Hammer's square face makes it easy to drive brads and nails—even in a corner. Other end starts tacks (left).

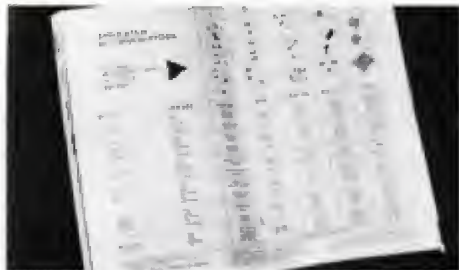
mine frequently, though it took some getting used to. It's \$8.65 postpaid from Woodcraft Supply Corp., 313 Montvale Ave., Woburn, Mass. 01888.—H.W.

### Hot stuff for welders

A new manual for those interested in maintenance and repair welding is available free from Nassau Research Corp., Box 175-PM, 1471 Jersey Ave., North Brunswick, N.J. 08902. The 80-page manual has prac-



Paperbound book measures  $4\frac{1}{2} \times 7\frac{1}{4}$  in., perfect size for carrying in a pocket.



Welding manual's 80 pages are pictorial, and they are arranged for easy reading.

tical information on how to identify base metals, principles and procedures for arc welding, and illustrated instructions for vertical, horizontal and overhead welding.—H.W.

### Getting a lift

Though I haven't personally used the device shown, I figured that PM's readers—an avid group of do-it-yourselfers—would like to learn of this backsaving item. Available at rental outfits for about \$15 per day,



This lifter makes it just as easy to install a drywall panel above the waist level (above) and on ceiling (below).



the drywall lifter has a 150-lb. capacity and can handle up to  $4 \times 16$ -ft. sheets. For information regarding availability, write Roland Young, Telpro Inc., Route 1, Box 138, Grand Forks, N.D.—H.W.

If you've come across a new product with some special features, let us know about it. Write to PM Workbench, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019.





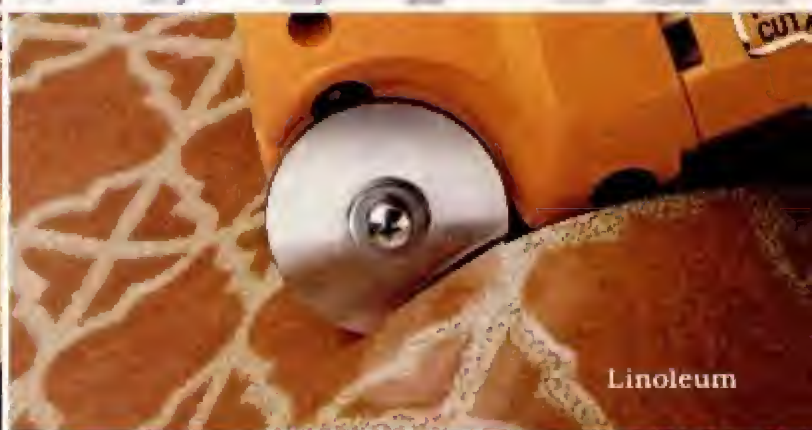
Carpet



Sheet metal



Insulation



Linoleum



Wire mesh



Canvas

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When you have a big, tough cutting job, you need a big, tough cutting tool. Introducing Black & Decker's new Rotary Power Cutter.

The Rotary Power Cutter has the horsepower and durability to slice through yard after yard of carpet, or sheet upon sheet of corrugated roofing, or stacks and stacks of linoleum. Name a material, and chances are the Rotary Power Cutter's two sharp, self-feeding cutting wheels can go right through it, fast. Insulation, wire mesh, asphalt roofing, heavy canvas,

fiber-glass, plastic, rubber, even 24-gauge steel.

And it's equipped with variable speed and reversing switches that let you cut along at your own pace, or back out of a tight spot.

So every cut comes out clean and precise with no jagged edges. In short, the Rotary Power Cutter does nearly everything tin snips, knives, and other manual cutting tools will do—only faster and easier and without doing a job on your hands.

When America has a job to do, it reaches for Black & Decker.



**Black & Decker.**



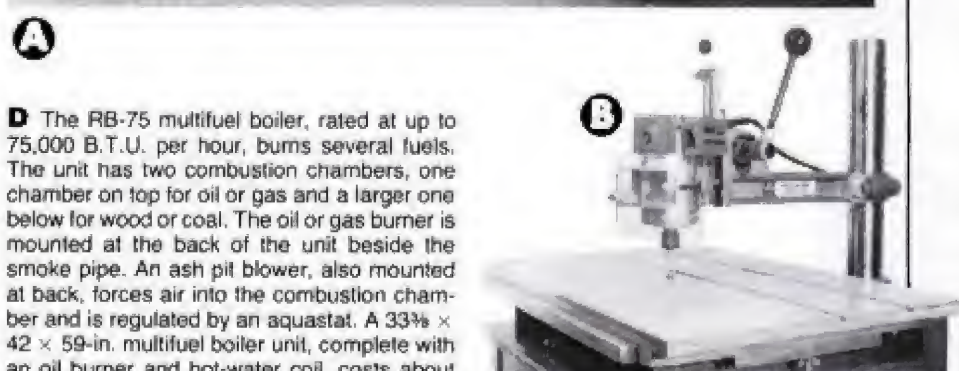


# NEW NOW for home and shop

**A** This safety pennant, the Dingle Safe-Distance, Reflective Cycle Guard, tends to make motorists steer away from cyclists. The pennant shows red to the rear and yellow to the front. Automobile headlights are reflected from the pennant back to the driver from as far as 600 ft., according to the company. The pennant's staff attaches to both pedal and motorized cycles by a pair of nuts and bolts. The pennant bobs in an attention-getting, up-and-down motion as you ride. A clip hooks the guard close to the bike when it's parked. The Cycle Guard is \$6 and is available from Dimension Weld Organization, 84 Commerce Rd., Stamford, Conn. 06902.



**B** Use this handy router arm (\$189) to rig your router for special production applications. A rear mounting clamp attaches the router arm to your drill press or other 2 3/4-in.-dia. vertical column. It holds a heavy-duty or commercial router up to 2 1/2 hp with a router body up to 4 1/2-in. dia. If you decide to convert a drill press or construct a router-arm mounting system, the router-arm table of 3/4-in. birch plywood, which is pregrooved for a rip fence with recessed pin-block assembly, costs \$57 and is available from Shopsmith Inc., 750 Center Dr., Vandalia, Ohio 45377.



**C** With this do-it-yourself fencing system, Select-A-Fence, you can enclose an area in your choice of three fence styles: board-on-board (shown), open picket, and solid privacy. The fencing system is made of pressure-treated Southern yellow pine and has three components: dog-eared 1x6-in. x 6-ft. planks, 4x4-in. x 8-ft. posts and 2x4-in. x 8-ft. rails. An 8-ft. section in the privacy style costs under \$45 and includes 18 planks, 3 rails and 1 post. The planks have one smooth and one rough-sawn side, and are available from Masonite Corp., Southern Lumber Div., Box 1569, Hattiesburg, Miss. 39401.

**D** The RB-75 multifuel boiler, rated at up to 75,000 B.T.U. per hour, burns several fuels. The unit has two combustion chambers, one chamber on top for oil or gas and a larger one below for wood or coal. The oil or gas burner is mounted at the back of the unit beside the smoke pipe. An ash pit blower, also mounted at back, forces air into the combustion chamber and is regulated by an aquastat. A 33 1/2 x 42 x 59-in. multifuel boiler unit, complete with an oil burner and hot-water coil, costs about \$2100 (cost of shipping is not included). Write to Riteway Manufacturing Co., Box 153, Harrisonburg, Va. 22801, for more information.







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Wheel Power. That's what Black & Decker's incredibly versatile Workwheel™ Power Stripper and Sander gives you. The power to turn tedious sanding and stripping jobs into effortless work.

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**Black & Decker**  
**WORK WHEEL**





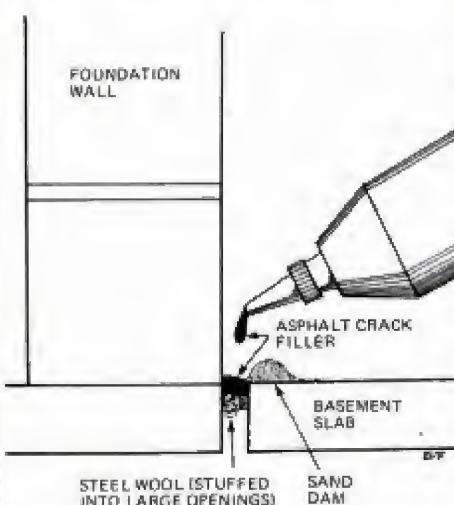
# HOMEOWNERS' CLINIC

## QUESTIONS ANSWERED

### Filling the gap

Bernard Fritch of Allentown, Pa., submitted a good tip for filling the gap between the basement slab and foundation wall. Sears sells a product called Blacktop Driveway Crack Filler that works on these basement cracks. It comes with a nozzle that facilitates pouring. When set, the filler makes a pliable yet firm waterproof joint.

For wide cracks, Fritch suggests first filling the crack with steel wool.



**Blacktop filler also seals basement crack.**

He also recommends building a sand dam along the area to be filled. Merely sweep away the sand after the filler has dried.

Sounds like a good idea to me.

### Smoothing things over

*One wall of the family room in my house is covered with grooved hardboard paneling. I don't want to remove the panels, but I want to paint the wall off-white, using a stipple paint. After test-filling the grooves and painting similar paneling, I found the grooves were visible through two coats of paint. What's the best method of preparing the walls for painting?—Ormond F. Fochtman, Honolulu, Hawaii.*

Preparing the paneling for painting is easy, but filling the grooves with a material that will not show future expansion and temperature cracks seems, to me, next to impossible. It would be so much simpler to cover the panels with  $\frac{3}{8}$ -in. drywall finished off conventionally. The next best thing might be to roughen the hardboard with coarse sandpaper and then fill in the grooves with

drywall joint compound and tape, just as you'd finish drywall. (See "Kitchen Ceiling Crack," *Homeowners' Clinic*, page 126, Jan. '79.) In effect, you're almost adding a finishing plaster coat; so prepare yourself for a good deal of work.

**Note:** Drywall compound is designed for use on drywall, not hardboard paneling. Thus, if you choose this method, you may be wise to test-fill a small area to see how it holds up. Or, try filling a test section of V-groove with a commercial wood putty. It is not uncommon, however, to simply paint over grooved plywood leaving the V-grooves as they are.

### House abuzz

William Schulz of Baytown, Tex., has a solid-state dimmer switch that is polluting his 110-v. house electrical system to the point that AM radio reception is terrible.

J.C. Umphrey of Condon, Ore., has 8-ft. fluorescent lights that are affecting the 100-w. public-address system in his church. The speakers and lights are close and can't be moved easily.

Bill, I called the manufacturer of your dimmer. A spokesman said that they have never had that complaint. He also said that in the event a defective dimmer slipped by quality control and you had the bad luck of getting it, you should send it to the factory or return it to the store where you purchased it.

Radio Shack carries an a.c. Line Interference Filter that might help both of you. It's item No. 15-1106, and it costs about \$5. The filter is plugged into a wall outlet and the appliance (radio or amplifier from a PA system) plugs into this filter. It is reported to remove any noises associated with AM house-current appliances.

### Flexible filler

*A professional plasterer is coming to my 100-year-old house to patch the hairline cracks in my living-room walls and ceiling. He said that after he does the job, the cracks will proba-*

*bly reappear. Are there flexible fillers or paints that will continue to seal the cracks?—Mark Lisowski, Rosendale, N.Y.*

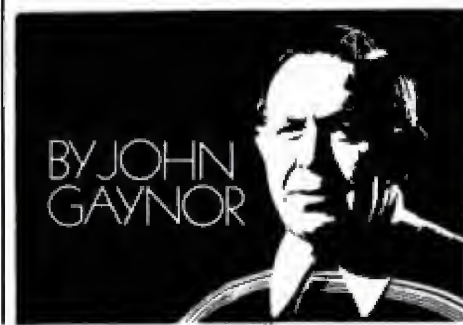
If I were a plasterer, I'd tell you the same thing. Not knowing the original makeup of your plaster with regard to scratch coat, thickness and other characteristics, a plasterer can't guarantee his work. Your walls are most likely on wood lath, which moves slightly with changes in climate and humidity. A pliable filler wouldn't work, as even it would show as a bulge or crevice.

One way to correct the situation is to install  $\frac{3}{8}$ -in. drywall over the existing walls and ceilings. You also may want to try paneling. An older house might lend itself to a paneled wainscot and heavy vinyl wall covering from the wainscot to the ceiling.

### Musty odor

*A musty odor that gives us headaches is coming from under our sink. A plumber checked the drains and vents. The city has checked the sewers and there are no leaks under the house. Nor are there any dead animals under it. This odor suddenly appeared two months ago in my 5½-year-old house. It's worse when it rains. If you can't help, can you refer me to someone who can?—Harold Lanmen, Winchester, Tenn.*

As you've had your sewage system checked thoroughly, I can only tell you what I'd do. After turning off the water, I'd remove the base cabinet under the sink. Then I'd remove the drywall behind the sink, as I have heard of cases where rodents have entered the walls from either attics or basements and, when they cannot find their way out, odoriferous decomposition follows. This may tie in with the two months you mention. You may want to get the opinion of a reliable exterminator before you tear your kitchen apart. **PM**



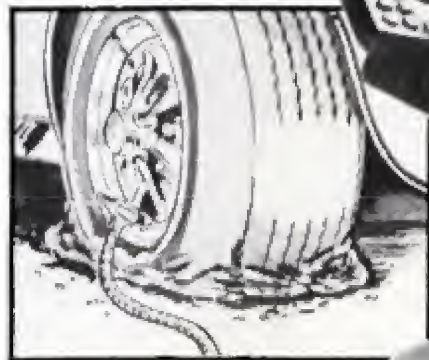
*Do you have a home maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in this column. For more home repair and maintenance help, get PM's Home Care Guide, \$4.95 postpaid. Send order(s) to PM, Dept. HCG, Box 1014, New York, N.Y. 10019.*



# DON'T GET STRANDED!

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in almost no time!

**SALE!**

NOT \$20. NOT \$15.

**\$9.88**  
only

**Gives 100 lbs. pressure  
in seconds! Completely portable!  
Foot-operated! Works anytime, anywhere!**

Great for bikes, toys, air mattresses and floats.

Amazing new air pump gives up to 100 lbs. pressure in just a few seconds! Pumps up tires jiffy-quick, so you're back "on the road" in almost no time. It's lightweight, compact, completely portable—needs no electricity, no tools, no special hookup. You operate it with your foot—just a simple toe-tap action, so easy a child can do it.

Puts an end to aggravation, frustration... saves you the hassle of searching for air at gas stations. Built-in gauge with EZ-Read magnifier lens registers up to 100 lbs.—Lets you control exact amount of air pressure. Comes with 24" clamp-lock hose that fits any tire or air shock. Folds to just 12½" for easy stashaway in car trunk.

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**Z494021... Automatic Foot Pump... \$9.88**

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# ALL OUTDOORS

## Small craft warnings

Boating has been a sport in which an individual could usually cruise off on his own quiet way in peace. Recently, however, it's become apparent that boatmen had better gang up and cooperate to keep from being marooned ashore. The U.S. Dept. of Energy announced early this year that it was considering a ban on all weekend pleasure boating as a gas-saving measure in all states that did not meet specific energy targets in case of an energy emergency.

No other sport or activity was mentioned. Boating apparently was singled out because it's a highly visible sport and had no muscular lobby in Washington to point out that boats burn less than one-half of one percent of all the fuel consumed in the nation.

Boatmen have started telling congressmen what they think of singling out water sport as a way of saving energy, while ignoring activities ashore. An equitable suggestion, of course, is to allow everyone a set amount of fuel, if that becomes necessary, and then let each person choose how he wishes to use it. Proper motor maintenance helps save on marine fuel consumed, industry engineers point out, and a light, well-powered, planing hull can back off one quarter on the throttle and get a smoother, more comfortable ride, while saving 35 percent on gas.

## Dangerous or disappointing

"Can I convert my runabout into a sailboat?" That's a question we've been asked often recently by boatmen considering ways to save on fuel. The answer: "Yes, you can, and no, you shouldn't."

As PM readers, we're the people who can do and build anything we want. Fortunately, we are also the ones who don't waste time needlessly, once we learn why some project may not make sense.

When the days of steam power began to move in on the windjamming square riggers, it was no great problem to add an engine in the hold and side paddlewheels or stern propeller to keep the ship going when the breeze died or blew the wrong way. Eventually, of course, the masts that held the sails were eliminated completely. Displacement freighter hulls didn't and still don't go a great deal faster than the speediest clipper ships when winds were right,

But today's light planing hulls that skim the surface of the water are not designed to perform properly under sail power. On a calm day, in sheltered waters with a light breeze, you could rig a sail on your skiff or ski boat and sail across the lake if the wind was going the right way, though you might have to row back home if you'd left the outboard ashore. A small powerboat has nothing below the bottom to keep it from sliding sideways in a beam breeze, or turning over, if gusts suddenly start pressuring the top of your makeshift mast like a lever. Sure,



The motor sailer may be a happy compromise for a fuel crunch. This 29-foot Kodiak is available in plans from Glen-L Marine.

you can attach leeboards on each side, hang a weighted keel below the hull or build in a centerboard trunk to house a daggerboard or swing keel that counteracts leeway and counterbalances the above-deck forces and tipping efforts of the sail. But once you've made all the modifications to make the hull stable, or reduced sail size enough to keep you on a semi-even keel, your "sailboat" may be so slow and difficult to tack that you might wish you'd stayed ashore. Like the old cargo schooners, smaller sailboats can be converted to power without too much trouble, but adding sail to a light, fast powerboat is usually not worth the effort. You're likely to get very discouraged, or drowned.

An exception is a larger craft, the motor-sailer. With a speed of nine or ten knots under power and almost that much when the wind is just right, it sets no sailing records and

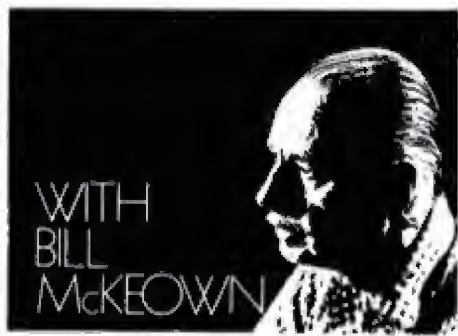
pulls no water skiers, but eventually gets where it's going and usually has room aboard to take along a full family. By shutting down the engine, except when needed for narrow channels, calms and currents, you can get a great range of action from the design. It deserves attention as a compromise in the future.

## How to—where to

Now that gas stations aren't a ready source for free road maps, a traveling outdoorsman needs to look around for the best one to buy. This year it's probably Rand McNally's new \$4.95 *Road Atlas* of the United States, Canada and Mexico. A comparison with previous editions (they go back to 1924) shows a large number of refinements and improvements in the 1980 version and explains how they spent over a million dollars in this year's updating. The locations of more parks, turnpikes, recreation spots and city details are among the many additions. While topographic maps and state tourist department maps are still the choice for hikers and shunpikers, this latest Rand McNally should be the one for your glove compartment.

The *BUC Used Boat Price Guide*, \$48 from BUC International, 1881 Northeast 26th St., Fort Lauderdale, Fla. 33305, gives the value on craft up to 10 years old, but now they've published a \$38 *Older Boat Price Guide* that goes back to 1905. Like guns and fishing gear, stamps and coins, old boats are becoming classics that increase in value. The new volume gives an antique boat owner a good start in evaluation.

Old-favorite sport books often seem to be unavailable or out of print. An excellent new source for buying, selling or searching for boating, flying, automotive and military volumes is the Transportation Book Company, 64 Eighth Ave., Brooklyn, N.Y. 11217. Author Warren Weith is the researcher. **PM**



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BILL  
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Seven and Seven have been going together for over 40 years. For a perfect marriage, just pour 1½ oz. Seagram's 7 over ice in a tall glass, fill with 7UP and enjoy our quality in moderation.

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Where quality drinks begin.



SEAGRAM DISTILLERS CO., N.Y.C. AMERICAN WHISKY—A BLEND, 90 PROOF.



# Before you spend any money for a new wagon, see what Oldsmobile's had built for you.

These are two of our 1980 Cruisers, the mid-size Cutlass Cruiser Brougham on the left and the full-size Custom Cruiser on the right. If you're looking for a wagon that'll give you solid value and loads of utility, you're looking in the right direction.

These are Oldsmobiles. You know they're solidly built. The ride is tuned to give you a quiet smoothness you might not expect from a station wagon. Corrosion is combated with galvanized metals, plastisol, aluminum-impregnated wax under-coatings and a

zinc-rich layer of primer. One slam of the doors will help tell you... Olds Wagons are built.

They're also very economical. They offer impressive mileage and range estimates. The EPA estimates below are for our available diesel V8.

These wagons also have Oldsmobile luxury through and through. Power steering, power brakes, automatic transmission and rich upholstery are but four of many standard features. And available options include nearly everything you would expect from a luxurious car. After all, these are the Oldsmobiles of station wagons.

See your Olds dealer. Compare price, mileage, engine choices, resale, luxury. Compare everything you want in a station wagon.

We think you'll be very satisfied with the station wagon

Oldsmobile's had built for you.



Cutlass Cruiser Diesel

<b>22</b>	<b>400</b>	<b>34</b>	<b>618</b>
EPA Est. MPG	EPA Est. Range	Hwy Est.	Hwy Range

Custom Cruiser Diesel

<b>21</b>	<b>462</b>	<b>31</b>	<b>682</b>
EPA Est. MPG	EPA Est. Range	Hwy Est.	Hwy Range



**Remember:** The boxed EPA estimates are for comparison to other cars. Your mileage and range depend on your speed, weather and trip length; your actual highway mileage and range will probably be less than the highway estimates. Driving range estimates are obtained by multiplying the EPA and highway estimates by the standard fuel tank capacity rating of 18.2 gallons for Cutlass Cruiser — 22.0 for Custom Cruiser. **Oldsmobiles are equipped with GM-built engines produced by various divisions. See your dealer for details.**

**Oldsmobile**

**WE'VE HAD ONE BUILT FOR YOU.**



# THE PM GARAGE

## CAPSULE REPORTS ON NEW AUTO PRODUCTS

### Digital auto alarm clock

You see a number of quartz-crystal car clocks on the aftermarket nowadays, but most don't have an alarm. Alarms can be handy in vans and campers when you need to wake up or remember to take dinner out of the fridge.

Sparkomatic's "Travelin' Time 3" Model SCL-3 not only incorporates a remote, plug-in alarm, but also tells



Digital alarm is compact, installs easily.

time and date on a lighted digital display. Installation takes about 15 minutes unless you sink the clock in your instrument panel.

You have only three wires to hook up: a hot lead, a ground and a wire that's hot only with the ignition on. This last lights up the display.

The Sparkomatic SCL-3 costs \$40 to \$45 at auto stores. It's made in Taiwan, distributed by Sparkomatic Corp., Milford, Pa. 18337.—*M.L.*

### Ten years of moonlight

When my car conked out recently on a dark and lonely road, I discovered that my flashlight had also joined the deceased. Next day I solved the dead flashlight battery problem with the purchase of a Moonlight.

It's powered by a C-size lithium battery that has a 10-year shelf life and provides 12 to 15 hours of steady light. The Moonlight will function at temperatures down to -65°F. The Lexan housing is unbreakable and



Moonlight boasts a 10-year shelf life.

waterproof, and the switch is recessed into the base of the light so there's no accidental battery drain.

The Moonlight is fully guaranteed. The \$17.50 retail price includes the lithium battery and three spare bulbs.

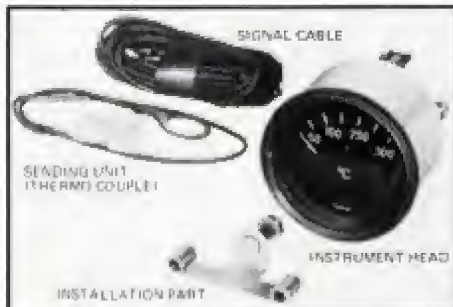
Order from Early Winters Ltd., 110 Prefontaine Place South, Seattle, Wash. 98104.—*Bob Berger*

### For hotheads

My biggest gripe for years has been the lack of standard equipment gauges on most cars. On some, you can't even get them as optional equipment. And idiot lights only tell you the story after a malfunction. If you want to avoid a malfunction, as I do, and cure it before it happens, a good gauge is the best insurance.

To make up for this lack of foresight by my car's manufacturer, I recently installed a VDO cylinder-head temperature gauge. The gauge comes with wiring, sending unit and mounting bracket.

Installing the gauge is no prob-



VDO gauge keeps track of temperature.

lem. Just remove one sparkplug, slip it through the sending unit and install the plug. The sending unit remains wedged between the cylinder head and sparkplug.

The only other wiring required is a splice into an existing power line for the gauge bulb.

The VDO temperature gauge is available at most auto parts stores for \$46.15. It is not available directly through VDO, but if you need more information, you should write to VDO-Argo, Box 2630, Winchester, Va. 22601.—*T.A.*

### Erase radio crackle

Does your car radio or stereo crackle and boom every time you turn the volume knob? If so, it no longer means a trip to the sound shop. Radio Shack now sells an aerosol clean-



Aerosol spray eliminates radio crackle.

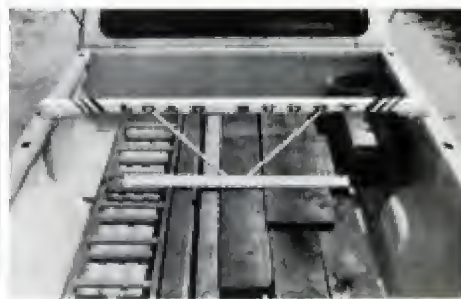
ing fluid that rids radios of boom-producing residue. Called Archer TV Tuner & Control Cleaner and Lubricant, it's simple to use. You take off the radio tuner knob and collar, insert the thin plastic "straw" and squirt. The cleaning fluid doesn't harm plastic or rubber, and it's non-flammable.

The six-ounce can is \$1.19 at all Radio Shack stores.—*M.L.*

### Pickup buddy

For anyone who carries loose gear in a pickup truck, here's good news from FKM Inc. Called Load Buddy, it secures anything from refrigerators to wheelbarrows.

Load Buddy is made up of two cross braces, one stationary, the other adjustable. The stationary piece bolts onto the inboard side of the bed wall; no drilling or welding is necessary. The adjustable brace is operated from a crank on the side of the stationary one. The unit is placed over the load and the mov-



Load Buddy holds anything in truck bed.

able brace is cranked down, pressing the cargo against the bed. The brace swivels to secure even irregularly shaped objects.

Load Buddy is at NAPA stores and other outlets for under \$120. For more information contact FKM Inc., 2699 South Bayshore Dr., Suite 600, Coconut Grove, Fla. 33133.—*T.A.*



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Buy The **ATLAS**  
6" Screw Cutting Lathe  
and get a  
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## IMPORTS & MOTORSPORTS

### Quick coupe



A coupe version of the 1981 Mercedes-Benz four-door sedan will soon be in production.

It still needs wheel covers and final trim for the showroom, but the basic shape of the new Mercedes coupe is down pat and in prototype. The two-door 2+2 will pair up with the smooth new sedans (see *Imports & Motorsports*, page 66D, Dec. '79) for the 1981 model year. Like the sedans, the coupe has been totally re-engineered for weight savings and improved aerodynamics. Don't call it "downsizing" though: Mercedes knows a potential customer squeezed into a small space might have difficulty reaching his wallet. There will be no squeeze on performance either, with choice of two strong engines likely: 3.8-liter aluminum V8 or five-cylinder turbodiesel.

### Contemporary classic

What's this, a restored Porsche 911, one of the shapeliest cars ever produced? Or is it a new fiberglass replicar sitting on a shortened Beetle chassis?

Neither. This is a new Porsche that's in full production. The 1980 911SC is as available as the two front-engine Porsches, the 924 and 928 models. But many people think it's gone the way of the old Speedster. The classic shape of the 911 (now 15 years old) should be around as long as customers will spend the \$28,000 the car costs today.

The rear-engine design goes back to the days of the first Beetles. In the 911, the horizontally opposed layout of the cylinders forms a Six that displaces three liters and is good for 172 hp. It's the same setup that will be used on Porsche's Indy car (see page 100) at the 500 this



Horizontally opposed Six, basis for racing engine for Indy, powers Porsche 911SC.

month. The Indy engine does develop a bit more horsepower, like 630 at 9000 rpm. When you see Porsche on Memorial Day weekend, you'll be reminded that the 911 lives!

### Birthday car

Another supershape in motorcars has reached a milestone. The Z-car was introduced 10 years ago and Datsun is celebrating with an anniversary edition that's one of the best values in the Grand Touring class. The 280-ZX10 is to the original 240-Z as power windows are to side curtains. The 240-Z (introduced at \$3500) has evolved into a very luxurious *Gran Turismo*. The base ZX for 1980 will set you back \$10,000, and

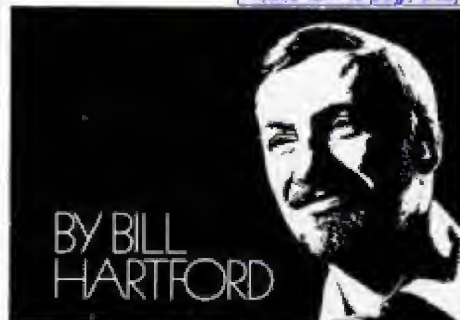


Datsun 280-ZX10 is for 10th anniversary.

the anniversary edition \$13,500, but when you figure that cars like the current British and Italian rag-toppers are commanding \$10,000-plus, the ZX becomes very hard to resist.

The black and gold anniversary edition shares the fuel-injected, 2.8-liter Six and the five-speed or automatic transmission that equip the base ZX. Special features of the ZX10 (3000 models of which will be available this year in the United States, include the following: T-bar

(Please turn to page 262)



BY BILL HARTFORD



**Pabst Blue Ribbon.<sup>®</sup>**  
**America's quality beer since 1844.**



© 1980 Pabst Brewing Company, Milwaukee, Wisconsin and other cities.



# Why did Bob Larkin buy the KZ440LTD with its 58mpg?

## Because Bob always believes in going the distance.

When Bob swung a leg over the KZ440 LTD and settled down into the high-step, dual-density cruising seat, he knew he was on a winner. The pullback bars seemed to reach for his hands. And a tap on the electric starter brought the call of the road from dual mega-

phone mufflers. Who could resist? Its 443cc overhead cam engine with constant-velocity Mikuni carbs delivered plenty of torque, so he could accelerate quickly and cruise effortlessly. Bob liked the fact that it was Kawasaki-reliable. And he appreciated the advantages

Kawasaki believes in riding safely. Check local laws before you ride. Member of AMA and MSF organizations and parts subject to change without notice. Model availability may be limited. Information available upon request.



of a silent cam chain with automatic tensioner. After all, there are better things to do on campus than to spend your free time working on a motorcycle.

When it came to handling, the KZ440 LTD exceeded his expectations. Precision-damped front forks and needle bearing swingarm gave him a real feeling of control and security. So did the drilled front disc brake. The fat rear tire provided lots of traction, and Bob sat down low with the center of gravity right under him. Riding it was a breeze — and sheer pleasure with a close friend on the back seat.

When you stop by your Kawasaki dealer to see the slick looking KZ440 LTD, be sure to see both the chain drive and belt drive models. You might even take a look at the new KZ250 LTD. It's a little smaller, but it's got some big numbers going for it. For openers, how's 80.2\* mpg grab you?



KZ250LTD

# Kawasaki

Don't let the good times pass you by.





# Come to Marlboro Country.



Famous Marlboro Red and Marlboro Lights—  
either way you get a lot to like.

Warning: The Surgeon General Has Determined  
That Cigarette Smoking Is Dangerous to Your Health.

Lights: 12 mg "tar," 0.8 mg nicotine—Kings: 17 mg "tar,"  
1.1 mg nicotine av. per cigarette, FTC Report Dec '79



# 'Imports' that made their mark at Indy

Light, agile and with smaller engines, they set the trends that lasted for decades.

by Pack Bryan

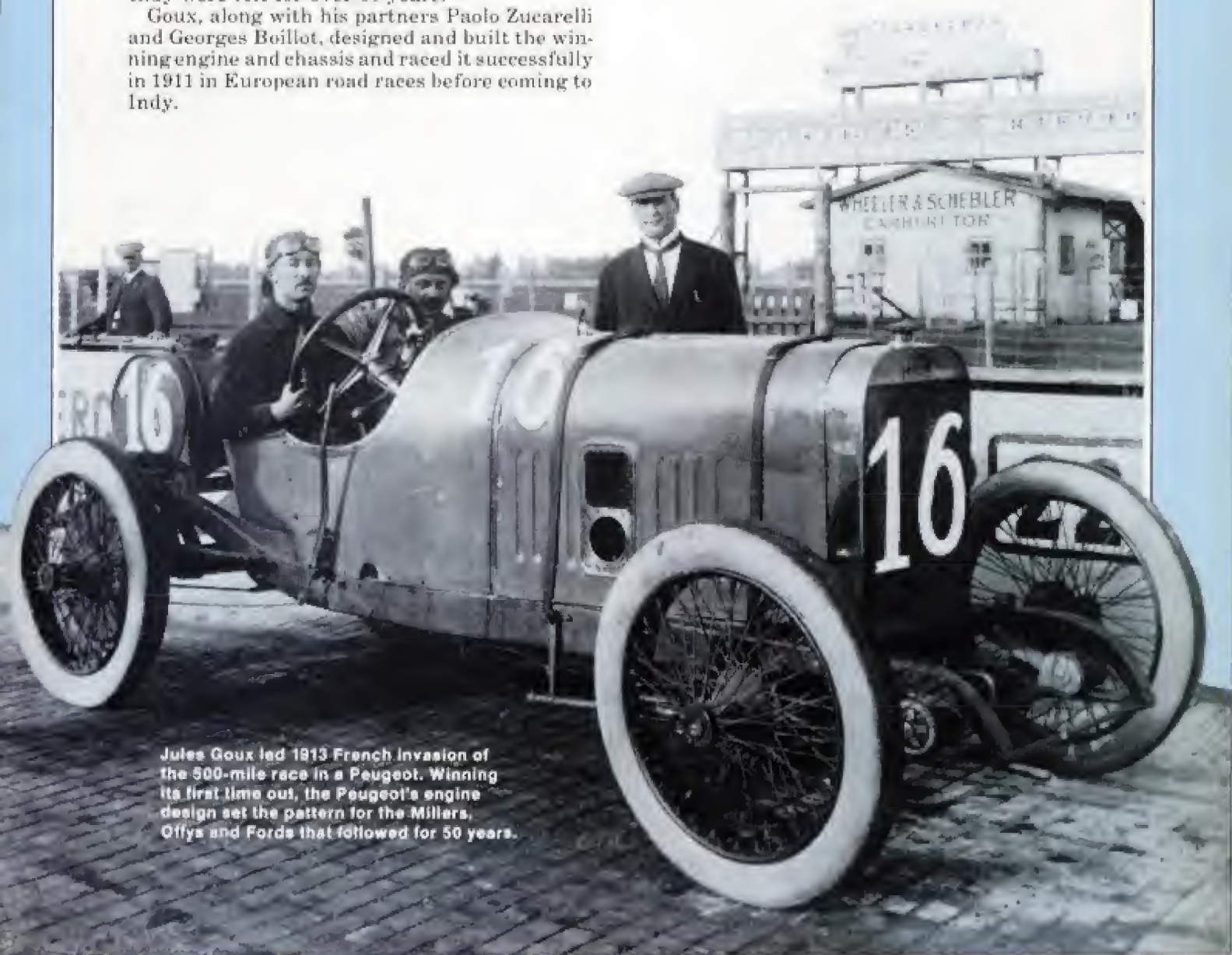
**T**he Porsche entered in this year's Indy 500 isn't very likely to win the race its first time out. But if it does beat the odds and find its way to victory circle (see page 100) it will make the same kind of impact made by another import back in 1913, when a French Peugeot convincingly beat the rest of the field and took the checkered flag.

The winning Peugeot was driven by Jules Goux, a Frenchman whose name is now almost forgotten by everyone except hard-core racing aficionados. His contributions and influence at Indy were felt for over 60 years.

Goux, along with his partners Paolo Zucarelli and Georges Boillot, designed and built the winning engine and chassis and raced it successfully in 1911 in European road races before coming to Indy.

While strictly conventional by today's standards, the engine design was daring and innovative for the period. For the first time in any single engine the Goux powerplant incorporated a one-piece head-and-block casting bolted to a barrel crankcase, four valves for each of the four cylinders and dual overhead camshafts. The overall package was light, strong and so simple and elegant in operation that the competition came away wondering why they'd never thought

*(Please turn to page 102)*



Jules Goux led 1913 French Invasion of the 500-mile race in a Peugeot. Winning its first time out, the Peugeot's engine design set the pattern for the Millers, Offys and Fords that followed for 50 years.



## Deutsche marque at Indy

*Armed with the latest in racing wizardry, Porsche tackles the Brickyard.*

**P**orsche has finally done it. After several years of rumors and conjecture, the tiny German manufacturer has announced it will try to capture the Borg-Warner trophy.

For the past few seasons Porsche engineers and racing personnel have been seen roaming the Indy pits with notebooks and calculators in hand. At the time, they denied any possible future participation at the Brickyard and stated they were only there as "interested observers." But those who know how the racing brains at Porsche work reasoned that the firm doesn't pound calculator keys unless it means business.

For once the rumor mills proved

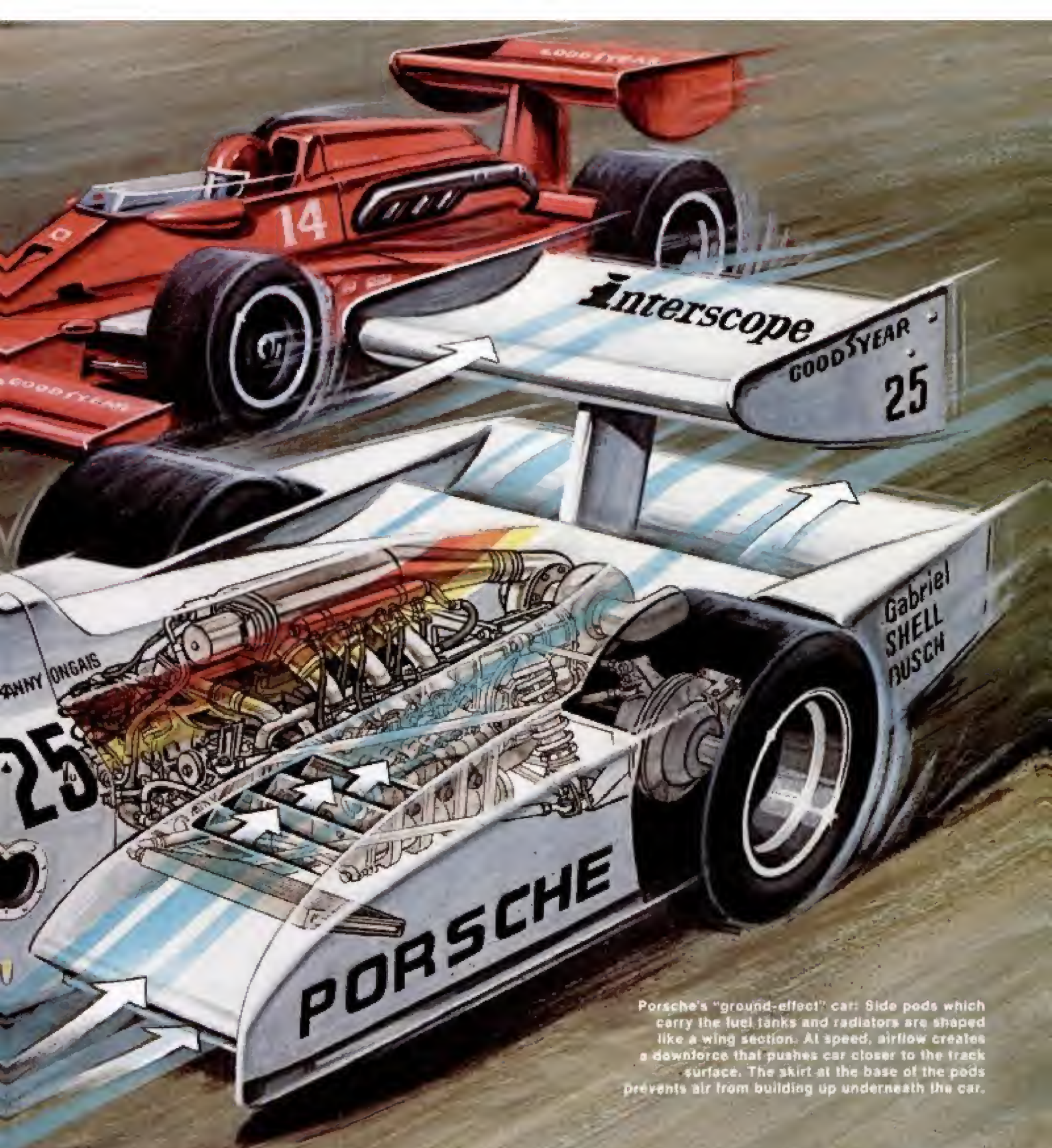
right. In late December 1979 Porsche announced that it had struck a deal with Interscope Racing Team to enter a factory-backed Indy car for the Memorial Day event. Danny Ongais was named as driver, an excellent choice since Ongais is considered to be the fastest man on wheels.

Ongais and Interscope were a logical choice since they've been fielding Porsche 935 turbos in IMSA GT events for several years. The Indy car engine is almost identical to the 935 engine so Interscope's familiarity with it should be an advantage when they take the car to Indy.

The racing success of this engine is impressive. It has won three of the







Porsche's "ground-effect" car: Side pods which carry the fuel tanks and radiators are shaped like a wing section. At speed, airflow creates a downforce that pushes car closer to the track surface. The skirt at the base of the pods prevents air from building up underneath the car.

last four Le Mans events and came in first at the Daytona 24-Hours in 1979. If nothing else, the horizontally opposed six-cylinder powerplant has proved to be durable and reliable for endurance events. Porsche feels the engine should have no problems staying together for the 500.

The flat Six displaces 161.7 cu. in. and produces 630 hp at 9000 rpm. It will, of course, be turbocharged and run on methanol.

To keep all that power on the

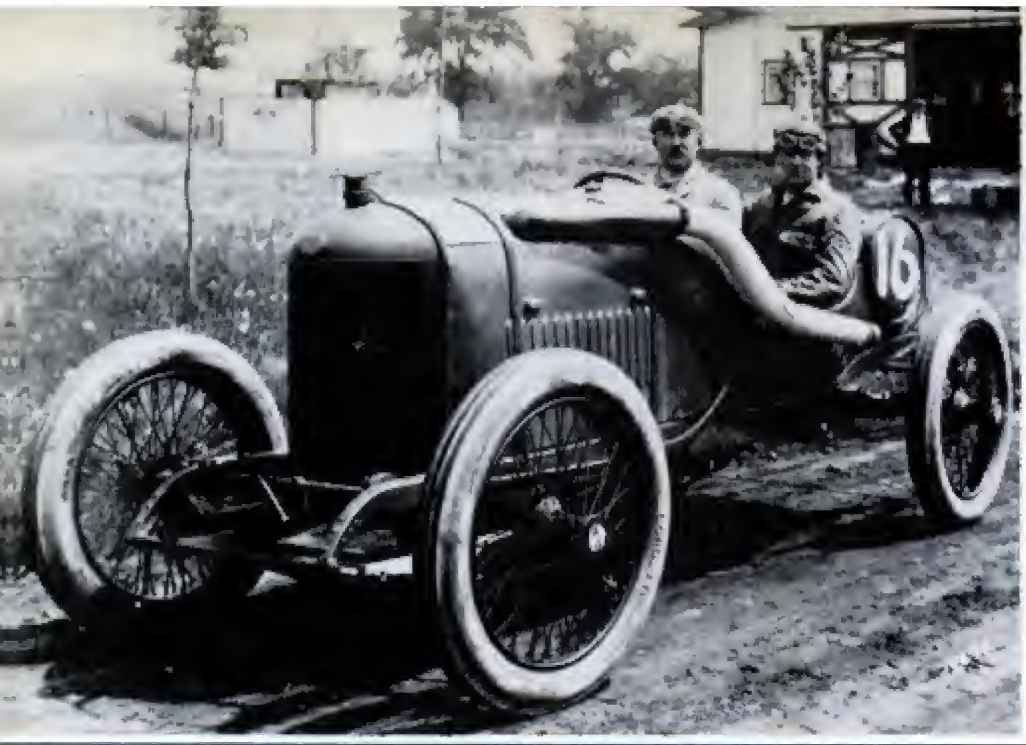
ground, Porsche has departed radically from conventional indy chassis design. Borrowing from current Formula 1 technology, Porsche has come up with a "ground-effect" body which essentially uses the entire body of the car as an air foil. The air rushing over the skin at speed pushes the car to the ground.

Another aerodynamic aid on the Porsche is the skirt, a flexible plastic lip which runs the perimeter of the car and touches the ground.

The combination of ground effect body and skirt work together to produce a vacuum under the car which literally glues it to the surface of the track.

If Porsche's racing history is any indication of success at Indy, it will be an awesome competitor. Armed with the latest state-of-the-art racing technology, Porsche will certainly give the regulars in Gasoline Alley at the Speedway a run for their money.—T.A.





Delage of Rene Thomas carried French tricolor to second Indy win in 1914, aided by tire troubles of his rivals. Delages took first and third, Peugeots second and fourth.



"Little engine that could" in this Cooper driven by Jack Brabham was a Coventry-Climax. Underpowered, car taught Indy racers real meaning of "handling" in 1961.

of it before. But it didn't take them long to adopt the design.

The Goux design was so successful, in fact, that it was quickly copied and raced by Sunbeam, Humber and Vauxhall in England, Delage in France, Opel in Germany and others in Italy and Belgium. But perhaps the most famous offspring of the original Goux engine was the Harry Miller creation that later became a Fred Offenhauser creation. The ancestral roots of the venerable Offy Four, which dominated Indy from 1935 to the early 1970s, can be traced directly to the Jules Goux design.

While the American competitors admitted that the Peugeot engine was stronger and certainly more sophisticated than the domestic products, they doubted that it would hold together for the 500 miles. Goux proved them wrong in beating the entire field by 13 minutes.

After the race Goux attributed his success to his engine and French champagne. It seems that on each visit to his pit for fuel and tires his mechanic handed Jules a pint of chilled bubbly. By the end of the race he had consumed some five pints of the stuff. That's not part of today's pit stops.

#### Another French victory

Of the 13 cars that finished the 1914 Indy 500, six were foreign. The winner, a Delage using its own version of the Peugeot Four, was driven by Frenchman Rene Thomas.

The American competitors were once again astonished by this European victory. A newspaper account of that race called it a "black day for America." While the result didn't

quite change the course of history, it certainly made many domestic competitors take notice. American racers realized that the 1913 Peugeot victory wasn't just a fluke; there was something to be said for the European approach to motor racing.

Barney Oldfield, the odds-on favorite, had shown up with a massive 434-cu.-in. engine fitted on a Stutz chassis. The Delage displaced only 380 cu. in., yet produced more horsepower. Despite superhuman effort to keep the big Stutz running with the pack, the best Oldfield could manage was fifth, coming in 20 minutes after the Delage had finished the race. Even more astonishing was the fact that the second-place car was a baby Peugeot, displacing a mere 183 cu. in. This car beat Oldfield by 13 minutes.

It seems that the lesson of high-revving, small-displacement en-

gines was not lost on the organizers or competitors because the following year, 1915, the formula for engine size was reduced from 450 cu. in. to 300 cu. in.

The biggest engine at the 1915 event was a Duesenberg 299 cu. in. driven by Eddie O'Donnell. The Doozie came in fifth while the winner was Ralph DePalma at the wheel of a 174-cu.-in. Mercedes. DePalma finished the race in 5 hours and 33 minutes. The Duesenberg showed up 40 minutes later.

Aside from its engine, the Mercedes had something else going for it

Wilbur Shaw won in 1937, 1939 and 1940. His supercharged Maserati had independent front-torsion-bar suspension, was headed for third straight win when wheel hub broke.







This car helped kill Indy "roadster"; its Ford engine almost did it to Offys. Jimmy Clark's 1965 victory in Lotus-Ford solidified chassis revolution.

which later influenced the appearance and construction of all Indy racers. The Mercedes was built around a then little-known principle called streamlining. Long before the Chrysler Airflow laid an egg and Raymond Loewy designed his streamlined locomotives, the ever clever Mercedes engineers realized that a big square bathtub on wire wheels was not as graceful and probably couldn't go as fast as a rounded, more streamlined shape.

The Mercedes sported a chiseled nose, a stretched boat-tail and a ful-



ly enclosed undercarriage. It certainly set the trend because from that year on every Indy car carried a bullet nose and pointy tail.

#### Between the wars

Despite Indy management's effort to reduce the cost of racing during the big depression of the 1930s with

displacement incentives for stock engines, the pure racing machinery continued to dominate the American scene. In between the war years, Europeans made rare and unspectacular appearances, leaving the way open for the Millers and Offenhausers to dominate the sport.

It wasn't until 1937 that the foreign influence began to be felt again at Indy and on other racing circuits.

At that time, Wilbur Shaw, who'd won the 1937 Indy in a Gilmore Offenhauser, began to take an interest in the Vanderbilt Cup races. These were European-style sprint races held on public roads, organized mainly for the amusement of gentlemen sportsmen who wanted to see how fast their import cars could go.

After a crack at a Maserati, Wilbur became an immediate convert. He begged his sponsor, Chicago millionaire Mike Boyle, to buy him a blood-red Maserati for Indy. Boyle was, at first, reluctant to give up a good thing and go for some high-strung, delicate little Italian road-

*(Please turn to page 256)*

Ascari's red Ferrari set hearts afire, but left timers cold. "Tail" gearing gave good straight-away speeds, but car couldn't stay with the Offys coming out of the turns.





# IT'S NEW NOW



## No moving parts

The Zeopower Co. of Natick, Mass., makes a solar-powered refrigerator that works like this: The solar collector on top is filled with zeolite, a mineral that "absorbs" water vapor. During the day, the collector heats up and the vapor is driven out to condensers underneath. The vapor condenses to water and trickles down to the evaporator/storage compartment in the fridge. At night, the zeolite cools, picking up vapor again and creating a pressure drop. (The system is a totally sealed vacuum.) The evaporator water then boils as it picks up heat from the fridge interior and the rest of the water. For every two pounds of water that boil off, about 14 pounds of ice are left behind. The next day, the ice melts slowly, cooling the fridge. Meanwhile, the zeolite exudes water vapor again and the cycle continues. Suited for use in boat, RV or back yard, the refrigerator will cost about \$500 in mass production.

## Inflatable rafts

These two inflatable life rafts, which together can hold up to 84 people, fit into a fiberglass cylinder only 5 feet long when packed. The RFD 42/84 life-raft cylinder is carried on a cradle on British hydrofoils and hovercraft. When dropped into the water, a pressure valve releases a catch and the cylinder opens into two halves. The rafts emerge and are said to inflate to full size in less than 20 seconds. Each raft is about 17 feet in diameter and about 5 feet high. Each has four entrances, two of which have steps to aid boarding from water level. When launched, the rafts are linked, but they can be detached. They're made from polyester-coated nylon by RFD Inflatables Ltd.



## Tabletop test

One way to hone your instrument flying skills is to go out and practice in an airplane. But this takes time and fuel, and incurs a certain risk. The ATC-710 flight simulator permits repeated practice of instrument navigation almost anywhere. Made by Analog Training Computers of West Long Branch, N.J., the basic unit costs less than \$5000. It's said to provide realistic flight situations with a series of recorded tape programs; time spent training with the 710 can count toward various Federal Aviation Agency licensing requirements, the maker says. Selector switches allow varying inputs for air turbulence, wind speed and direction.



## Boat tote



Sometimes large boats have to be taken from the water to a destination on land, in this case a trade show. It's a difficult process, now made easier by the Euro-lift. Basically a crane that can travel into the

water or down the road, it was built by the Wenzlaff firm in Germany. The crane can carry boats from about 30 to 80 feet long, weighing up to 100 tons, and it is capable of adjusting to various types of terrain.

## Iron butterfly

This 32-foot-diameter butterfly valve, said to be the world's largest, will be installed at the Arnold Engineering Development Center near Tullahoma, Tenn. It weighs 170 tons; yet the butterfly itself can be opened or closed in 60 seconds against air velocities exceeding the speed of sound. The half-mile-long wind tunnel cost \$437 million to build. The valve (with truck shown on it for scale) helps isolate one bank of compressors from another so that the pressure and volume of air running through the wind tunnel can be controlled. It will be used during high-altitude simulations on aircraft engines, when the tunnel is at partial vacuum. The British-built unit is by Markham and Co. Ltd.



## Energy monitor

Would homeowners conserve more energy if they could see quickly how much money they were saving? The Department of Energy thinks they might, and is conducting an experiment to find out. About 600 energy-cost indicators have been placed in homes in four U.S. and two Canadian cities. The 10x12x3-inch unit shows the time of day and the cost of gas and electricity as it mounts, for 24 hours from midnight to midnight. It also provides a readout of utility costs for the previous day, cost for the next hour if no appliances are turned on or off, and accumulated monthly costs. The prototype devices measure only gas and electricity use, but could be modified to measure oil use. If the feedback concept works, smaller and cheaper consumer versions of the indicator should become available.



# FIGHTING THE WORLD'S WORST OIL SPILL

After fire ravaged the floating drill rig, the oil slick headed for the U.S. coast.

by John F. Pearson

**I**t came with a roar, a cannon shot from the deep. There wasn't a crewman on the floating rig who didn't instantly know what had happened: The well had blown out!

It was 3:13 a.m., Sunday, June 3, 1979, when Ixtoc 1, a six-month-old exploratory well owned by Mexico's Pemex company, went wild. The thunder in the Bay of Campeche, just west of the Yucatan Peninsula, signalled the beginning of the worst blowout in the history of deep-sea drilling. In the months that followed, the blowout frustrated dozens of technicians who tried to fight the flow with everything

from a robotic diver to a 310-ton "sombbrero" hung down in the blue-green Gulf of Mexico waters to trap oil. The flood of oil imperiled the Texas coastline hundreds of miles away to the north. And that morning when the well erupted, it threatened the lives of everyone aboard the rig.

The big semisubmersible drilling rig shuddered and rocked as liquid and gas—driven by the 6000-pounds-per-square-inch pressures in the oil-bearing formation two miles below—surged through a 30-foot section of pipe projecting up from the deck. The crew had been trying to unscrew the pipe from the drill string

Burned-out Sedco 135 rig (right) remained afloat after fire swept across its deck. A \$22-million loss, the rig was eventually towed 200 miles out to sea and scuttled.

Blowout occurred 50 miles northwest of Ciudad del Carmen, Mexico (map, below). Current swept oil along coast toward Texas where contamination affected some 140 miles of coast from Brownsville northward.



Like an eerie sunset, a reflection of fire on Gulf waters silhouettes tug/supply boat at blowout site (right). Line marking oil slick shows in photo (below) of unidentified vessels at the offshore well six months after the initial eruption of oil.







Blunt bow of flattop work barge, *Able Turtle*, nosed into edge of the flames (top). Divers attempting to locate leak (above) required hosing down as deck temperatures rose to 145° F. The remotely piloted underwater vehicle (left) finally found the source of oil plume, then got caught in its upward vortex. The turbulent ride to the surface banged up electronic components.





Legendary Texas oil-well tamer Paul N. (Red) Adair (second from left) watched TV pictures of sea floor to survey damage at wellhead. Underwater cameras that carried the lights transmitted the murky, jungle-like scenes of debris. Early hopes of containing blowout faded quickly as plan after plan failed to cap the well.

Photos by Martech International Inc., John Pearson, and U.S. Coast Guard

when the well blew, scrambling the pipe's threads, causing it to whip from side to side like a loose water hose under full pressure. Now it spewed drilling mud and crude oil, scattering men, tools and sections of pipe.

Crewmen rushed to shut down electric motors and diesels: A spark could turn the rig into an inferno. But their luck ran out. Surging gas ignited. Fire streaked along the deck as the men ran for their lives. Though some suffered injuries, all managed to make it to lifeboats. Within minutes, they floated on the dark waters of the Gulf, looking up at a towering island of fire.

### World's largest Tinker Toy

The rig on the job was the Sedco 135, a triangular-decked semisubmersible (a "semi" in offshore lingo). It resembled a huge Tinker Toy, with a deck the size of a football field sitting on long steel legs.

The Sedco 135, owned by a Dallas

company, was leased on a modified bareboat (no crew) contract, with only seven Sedco personnel aboard to keep a proprietary eye on it and to offer advice as needed. The rig was operated by a 63-man crew from Permargo, a Mexican drilling firm.

Semis are capable of working in very deep water. So the 165-foot depth at the Ixtoc 1 site was no strain for the Sedco 135. The rig continued to drill month after month, adding hollow drill pipe in 30-foot sections as the hole deepened. By June 1979, the pipe string reached nearly 12,000 feet. The big knobby bit was punching through rock within some 600 feet of the target depth.

On June 1, the drilling crew spotted the first sign of trouble—a loss of circulation of the drilling mud. The mud, usually a mixture of water, clay weighting material and various chemicals, is injected into

the pipe. It spurts out through an opening in the bit, providing cooling and lubrication as the drilling proceeds. It carries rock cuttings up in the space between the drill and the wall of the hole and then back to the platform in a hollow riser pipe which surrounds the drill. On the rig's platform, the mud pours into tanks, where cuttings are separated before the fluid flows back down again.

When a loss of circulation occurs, it usually means that the mud is disappearing into fractures in the rock. From experience with other wells in the area, the Mexican engineers decided that the situation probably was temporary. And later in the day, reassuringly, the mud did begin to circulate.

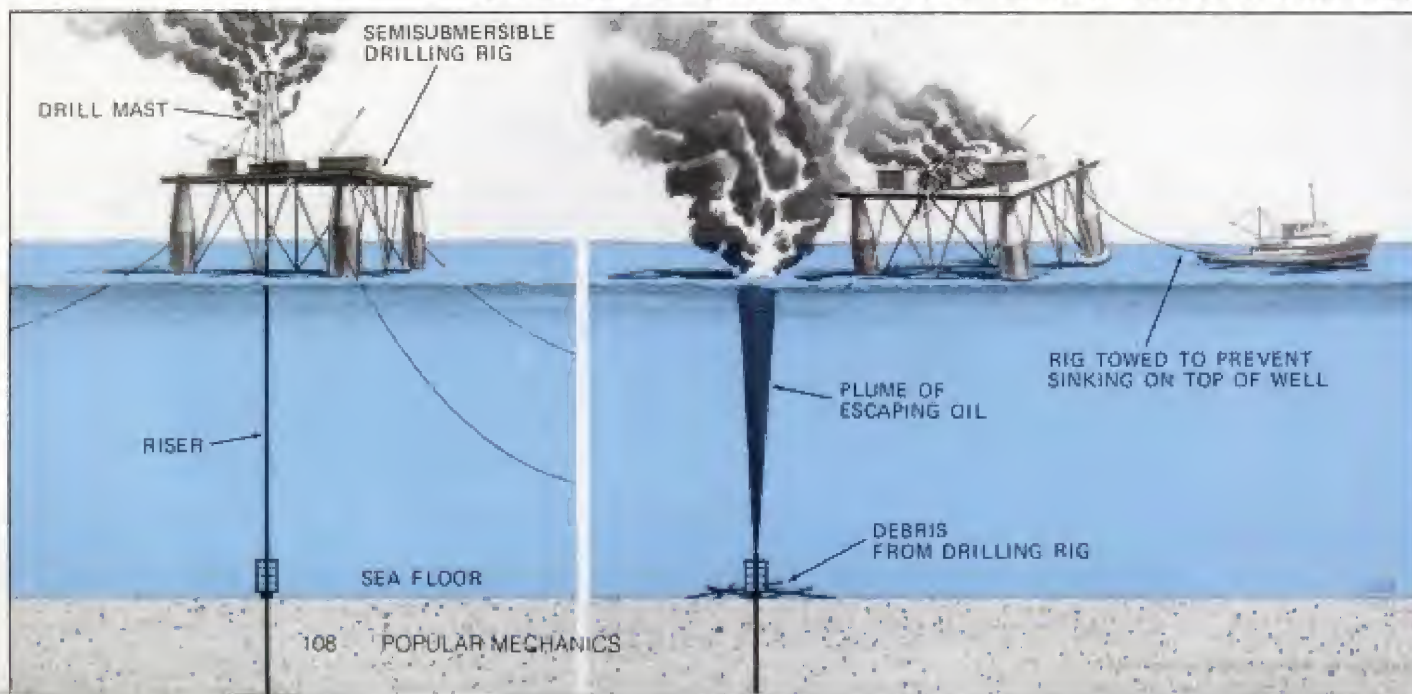
But on June 2, circulation stopped again. Ten hours later, it had not recovered. The crew decided to take drastic action: Pull up the whole drill pipe, take off the bit, send it back down and pump material to seal off the rock fractures through the drill's open end.

The Sedco engineers reportedly were not happy with the plan. They feared that pulling the long string of pipe could have a swabbing effect that would stimulate the flow of oil. They wanted to shut off the drilling hole at the sea floor—at least temporarily—with a gel or cement plug.

### Blowout!

But the Mexicans went ahead. By 2:30 next morning, they had tripped out more than two miles of drill pipe. Remaining was a last 30-foot length of this pipe plus a 900-foot-long string of thick-walled drill pipes—called drill collars. Used at the bottom end of a string, the hefty drill collars put extra weight on the bit.

After blowout (below, left), boat pulled rig away from drill site. Riser pipe broke, leaving a plume of crude oil behind. At first, the Ixtoc 1 well leaked some 30,000 barrels a day.







A little girl sifted tar balls from the sand (left) and crews raked black patches (far left) after oil hit Texas coast. Coast Guard deployed the booms (above) at inlets to protect the lagoons behind a string of protective islands.

As the drilling crew wrestled with the joint projecting above the deck, they saw fluid spurt out around the lower end of the pipe. Pressure built fast. Mud and oil erupted with a roar, angling the pipe. Now there was no chance of pulling it out. The pipe was cross-threaded, jammed.

With a raging blowout on their hands, there was only one move the Permargo crew could make. They had to try the blowout preventer (BOP) attached to the well on the seafloor. The drill pipe passes through the BOP, which is a 40-foot-high stack of high-pressure valves remotely controlled from the surface. Typically, the BOP is equipped with three or four steel rams that

can slam through the wall of ordinary drill pipe to close off the hole. But the rams aren't powerful enough to penetrate the thick-walled drill collars—and it was a drill collar that now rested in the BOP.

The Mexicans activated the BOP. But the flow continued. And now volatile gas, mixed with the spurt-ing crude, ignited on deck. The fire warped metal panels, bent girders and caused bolts to shear. The main deck heaved as its supporting structure weakened. The rig began to list. Tools, hoisting gear, motors and most of the derrick atop the rig

plunged into the sea to join 12,000 feet of drill pipe that had slid off the deck.

It took five hours for workboats and tugs, brought to the scene by distress signals, to put out the fire. Tugs sailed through flaming water to cut the rig's anchor cables, then towed it some eight miles from the site to make sure it wouldn't sink on top of the well.

Weeks later, the big rig, by then deemed a potential navigational hazard as well as a \$22 million loss, was towed 200 miles offshore and scuttled in deep water.

### Spill marked by fire

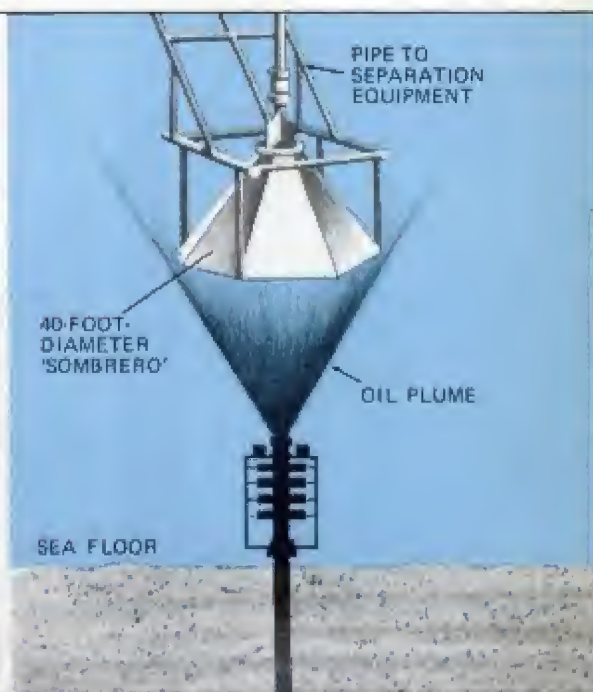
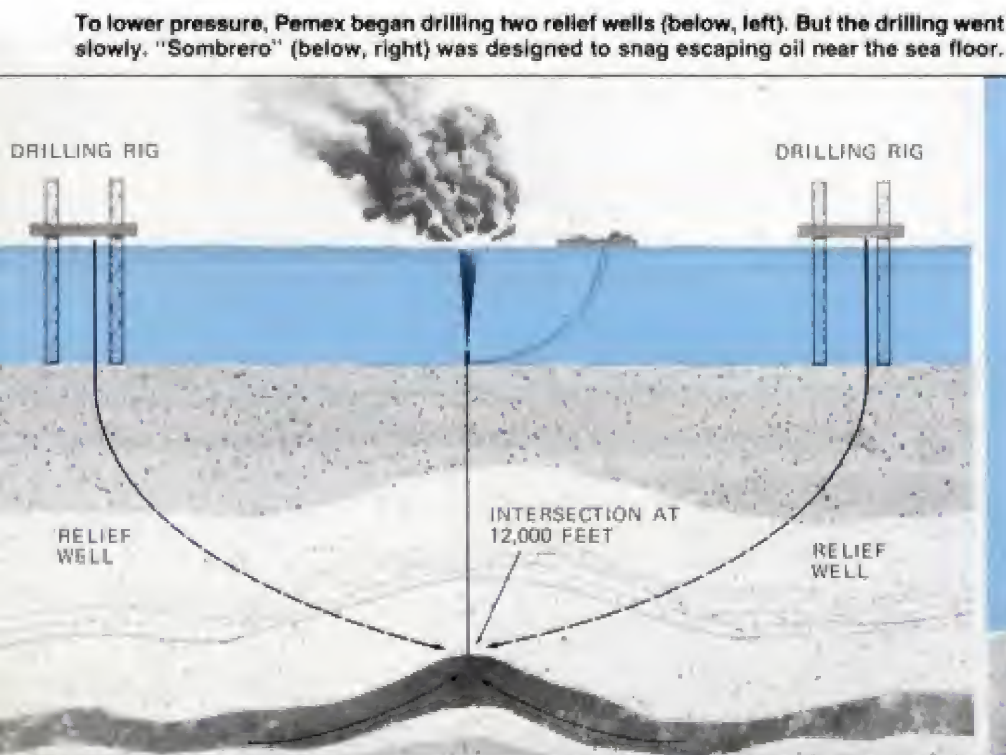
A circle of yellow-orange fire, about 150 feet in diameter and 20 feet high, marked the location of Ixtoc 1. Water welled up under the flames and a tan slick of oil extended out several hundred feet from the fire. The well was leaking some 30,000 barrels a day, about 875 gallons of oil every second.

Though Pemex is an experienced—and proud—oil company, it had to reach for outside help. Soon, a small armada of tugs, workboats and barges stood by. The *Tolteca*, a large, well-equipped derrick barge owned by Netherlands Offshore, was towed from a nearby site where it had been involved in platform-installation work. A flattop work barge, the *Able Turtle*, joined it.

But more than equipment, Pemex needed the know-how of specialists. One of the first called upon was Paul N. (Red) Adair, the legendary Texas oil-well tamer whose work garb is a pair of fiery red coveralls. What Red advised or did is a matter of speculation; he has been uncharacteristically tight-lipped about this job.

Red and his team were hampered

*(Please turn to page 258)*





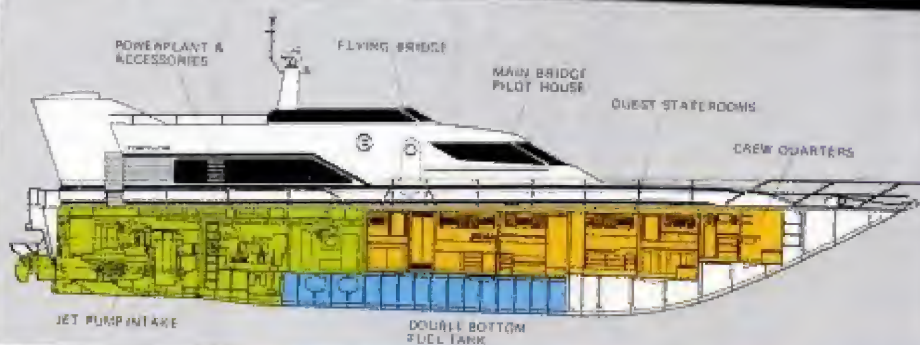
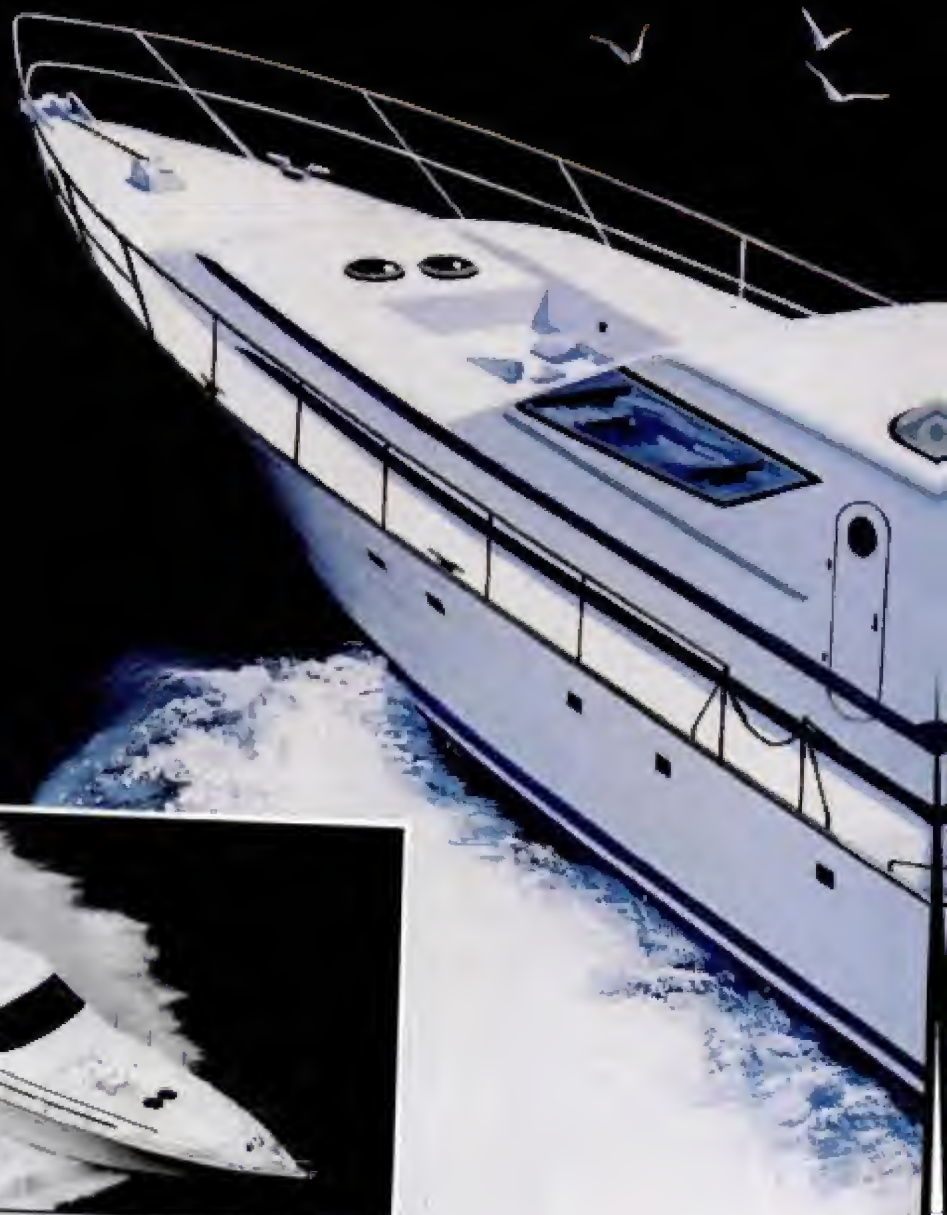
# FIRST POWER,

**W**hen Crown Prince Fahd of Saudi Arabia decided to make a gift of a new royal yacht to King Juan Carlos of Spain, it was clear that the result would be something extraordinary. The King is an avid boatman and former Olympic sailor, but the possibilities for urgent matters of state suddenly arising in mid-cruise called for a vessel with a little extra turn of speed.

Britain's Don Shead, a naval architect specializing in racing powerboats, designed the King's *Fortuna*. Into an 86-foot hull, Shead inserted ample accommodations for "family cruising" and then went to work in the powerplant department. A combination of two MTU (West German) diesel engines plus an Avco Lycoming gas turbine operating through a 9 to 1 reduction gearbox drives three Rocketdyne water jet pumps—giving *Fortuna* a flat-out speed of over 60 mph and shallow-draft capability (because no propellers protrude) to boot.

Palmer Johnson, a Wisconsin firm specializing in custom yachts, built *Fortuna* using aircraft grade aluminum and the resulting aircraft construction techniques to form the vessel's sleek, deep-V-type hull.

PM



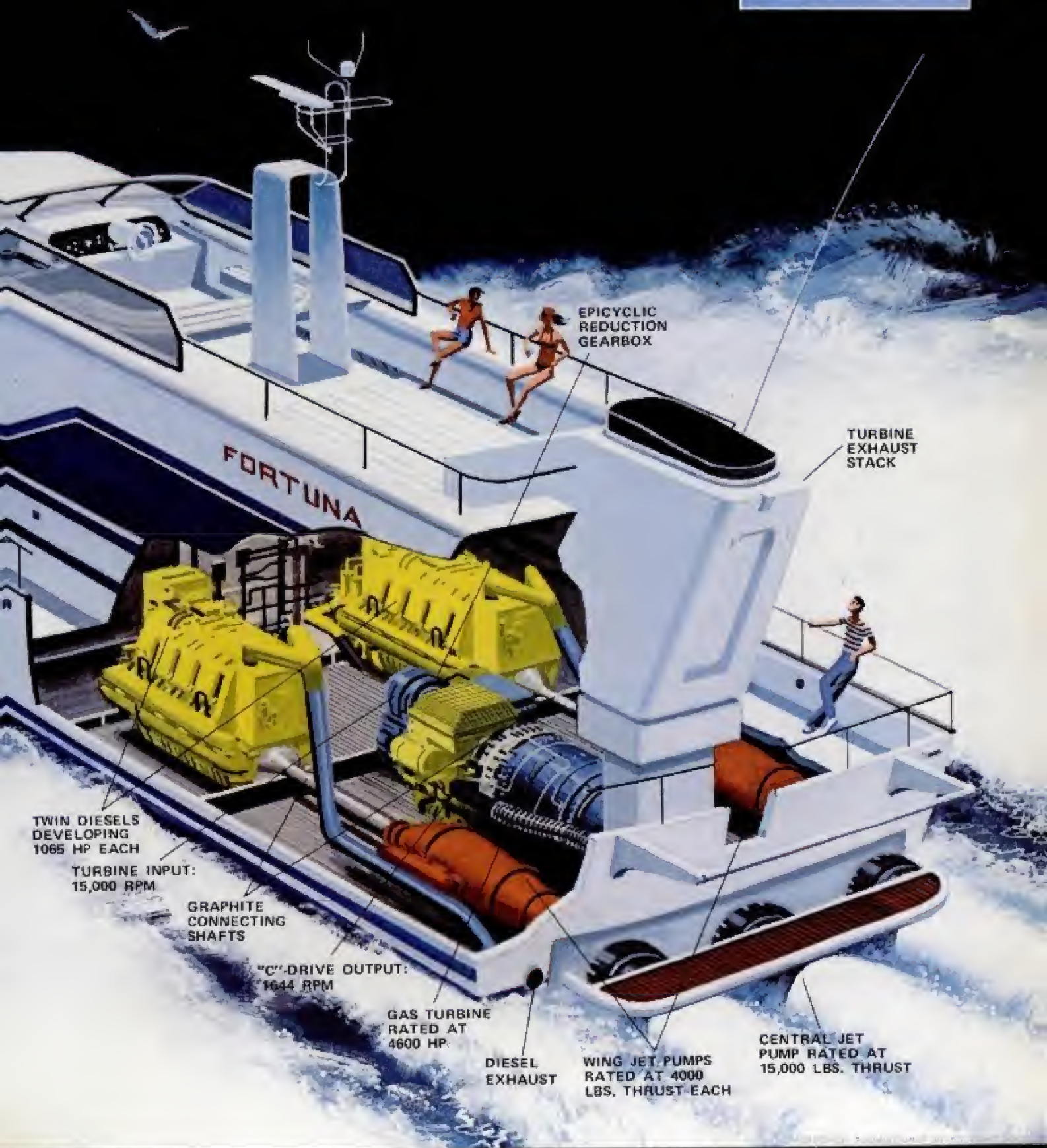
Running at more than 50 mph (photo at top), the *Fortuna*'s turbine/diesel combo powerplant pushes her up over bow wave. Double

bottom aft holds large fuel tanks; interior layout includes owner's stateroom, five cabins, crew quarters, grand salon and galley.



# THEN GLORY

Royal yachts used to be floating palaces, but when the King of Spain wants to truck it on home in this one, he can hit 60 mph.





**T**his Owners Report shows once again that all too few Americans really know what they're buying—even when they pay an awful lot for it.

Case in point: the 1980 Cadillac Seville. Primary reason for buying: styling. Our survey shows that 54.7 percent of Seville owners bought this car because they like the way it looks.

Sure, I like its styling, but where's the appreciation for the Seville's many technical innovations? Where else are you going to find so much advanced, impressive technology all in one car?

Not in a Mercedes, I'm afraid, and not in a Rolls either because, among other things, both lack front-wheel drive. Admittedly, it's hard to make point-by-point comparisons, but to me the Seville does come out on top, especially when you add in the electronics.

About 60 percent of all cars Mercedes sells in this country are now diesels. Is it any wonder, then, that Cadillac decided

## PM OWNERS REPORT CADILLAC SEVILLE

to make a diesel V8 standard in its '80 Seville?

The surprise comes when you check the miles-per-gallon figures in our data panel. Here's one car that allows a direct comparison of diesel versus gasoline economy. Note that the Seville diesel does 6.2 mpg better in town and 7.8 mpg better on the highway. The Seville diesel, in other words, betters Cadillac's gasoline V8 by 44 percent in open-road driving and 47 percent around town!

Is there a penalty? Yes, say Seville diesel owners, but it's a small one. A New York real estate agent sums it up this way: "Acceleration and general performance are good for a diesel, I suppose, but slow when compared with a gasoline engine."

Engine noise came in as the Seville's most-often-cited complaint. But even so, only 12.9 percent of our respondents mentioned it. The muted diesel clatter came as no surprise to any owner. Actually, I felt it was cited more as an annoyance than as a real complaint.

The ratio of Seville diesels to gasoline-engine cars was very nearly the opposite of the Mercedes figure. Fifty-seven percent of the owners we surveyed opted for the gasoline Seville. And although the diesel V8 comes standard, gas-engine Seviles cost \$266 less.



Seville's classic styling and compact size brought praise from all owners we polled.



Wood-grain dashboard simulates walnut and teak. Climate control is standard.

A California trimmer told us, "The gas mileage of my gasoline-powered Seville isn't what the company claimed it would be. I'm only getting nine mpg around town so far."

Lower-than-expected fuel economy

BY MICHAEL LAMM WEST COAST EDITOR

## Great styling, comfort and technical innovations, but workmanship isn't up to imports

Seville shares Eldorado's sheet metal and mechanical components from dash forward.

Bustle trunk lets luggage ride upright, has 1.7 cu. ft. more space than last year.





with gas-powered Seattles ranked as high among owners of those cars as did noise with diesel owners.

When we asked respondents to list specific likes and dislikes, the following were typical.

An Ohio security engineer: "Fantastic gas mileage, comfort, styling and resale value."

A Michigan investor: "I like the Seville's handling ease, comfort, appearance, trunk space; it's a very fine car all around. My only regret is the diesel engine, which lacks passing power, and the fact that there are too few diesel stations. When I find one, I usually end up filling the tank myself, too often at dirty truck stops."

A New York corporation president: "I



Without a differential, trunk is deeper, accepts large suitcases upright or on side.

like the styling, especially of the Elegante. About the only thing I don't like is the fact that when you take this car through a car wash, it invariably demolishes the wire wheelcovers."

A Louisiana oil processor turned out to be one of the few owners who applauded the Seville's technical features. "I appreciate the electronic advances, the front-wheel drive and independent rear suspension which makes for better handling and ride."

On the negative side, this same owner told us, "The paint is good but not excellent. I'd like a stiffer front suspension, because the front end bottoms more easily than our '79. The wire wheelcovers tend to be noisy—they click and clack a lot. This is worse when the weather turns cold."

Asked specifically about the Seville's quality and workmanship, 74 percent of our owners rated it *good to excellent*. That might be in a league with other American luxury cars, but it's nowhere near the imports—not even those costing a third as much.

First, compare the Seville's 74-percent *good to excellent* rating with 97.4 percent for Mercedes, 88.8 for BMW, and 81.5 for Jaguar. Then note that price has little to do with quality ratings, as evidenced by the following figures from previous Owners Reports: Audi 5000 and Mazda 626,

*(Please turn to page 274)*

## State-of-the-art Seville

The Seville is technically far above most of its luxury-class rivals and perhaps five to seven years ahead of the average American-built automobile.

Where else will you find front-wheel drive, a diesel V8, four-wheel independent suspension with torsion bars up front and coils aft, four-wheel disc brakes, fuel injection, electronic load leveling and an electronic climate control system?

The Seville's standard engine is an Oldsmobile-supplied 350-cu.-in. (5.7-liter) diesel V8 with mechanical fuel injection, rated at 105 hp net.

You can also get Cadillac's own 368-cu.-in. (6.0-liter) gasoline V8 as a \$266 delete option. Outside California, this 6.0-liter V8 rates 160 hp, and inside California it's 145 hp with digital electronic fuel injection. This sophisticated system can not only diagnose its own malfunctions, but has the ability to temporarily "heal" itself via built-in fail-safes.

Almost everything that's optional on other cars comes standard on the Seville. You get power reclining seats, glass defoggers, heated outside mirrors, cast aluminum wheels, an 80-amp. alternator and lamps everywhere.

If you need more, there's an MPG Sentry with instant readout, a trip computer, garage-door-opener package, a theft-deterrent system and puncture-sealing, steel-belted radial tires, all optional.

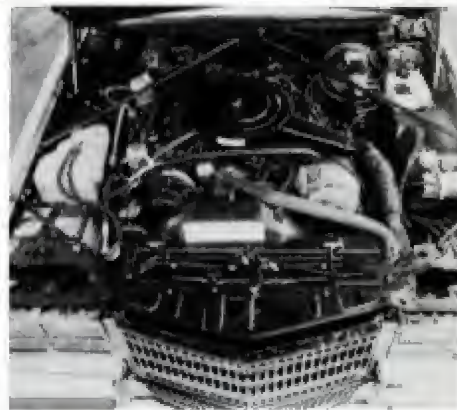
The up-style Elegante package, which includes two-tone paint, leather seats, and the choice of wire wheelcovers, costs about \$3000 more than the Seville's \$19,662 base price.

## A NATIONWIDE SURVEY BASED ON 678,155 OWNER-DRIVEN MILES

Standard diesel V8 delivers 105 hp, gets about 45 percent better fuel mileage than its gasoline cousins at 145 and 160 hp.

Electronic fuel injection on 49-state gas V8 uses self-correcting computer.

Diesel V8 comes standard, but you can get Cadillac's 368-cu.-in. gasoline V8 as a delete option.



Front-wheel drive rates high with owners, aids winter traction, eliminates floor tunnel, adds to roominess.



# 12 subterranean pioneers report: 'It's great to live underground!'

In 1977, PM reported that architects were beginning to design earth-sheltered homes to save money and energy (*Your Next House Could Have a Grass Roof*, page 78, Mar. '77). Now residents have tested underground living. Here's what they say.

by John Ingersoll

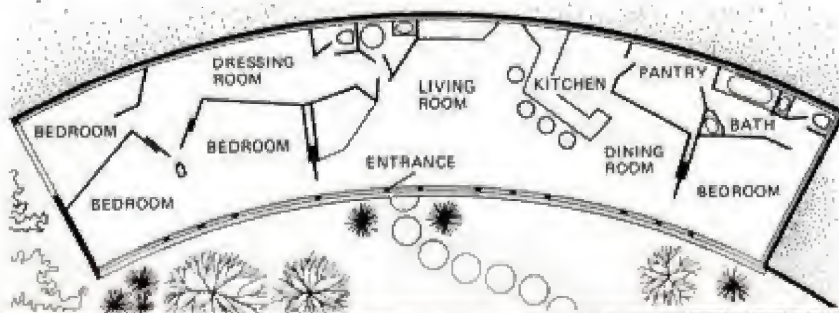
**U**nder no conditions would we ever live in an above-ground house again," say George and Ruth Hagman of Broken Bow, Neb. "Our earth-sheltered home is positively the most comfortable we've had. We like everything about it."

A report from a maverick? A line from a television commercial? No. Every owner of an underground home told me essentially the same thing. Try as I might to dredge up some negative remarks from 11 families here and one in France, I was rewarded with a mere sprin-

gling of minor complaints. However, the only solidly negative views came from people now living above ground—people who had never seen nor been inside an underground house.

## A new crop of houses

That includes most of us, of course, because the number of underground houses remains low. There are between 2000 and 4000,



Countryside around Valbonne, France, is damp, but Jean Giannesini and his family find interior (above and below) of their earth-sheltered home dry. House is open in front, curves into hill (left).





according to Thomas C. Atchison, executive director of the American Underground-Space Assn. (AUA) of St. Paul, Minn. But Atchison told us that the number of underground homes is growing rapidly.

The 3-year-old AUA, a nonprofit organization of architects and others interested in underground structures, expects to double its current roll of 1000 members by next year. And the number of houses has increased from just a handful in the mid-1970s.

Despite the flowering—or rooting—of interest, many above-grounders remain wary. Here's how people living underground responded to five of the most-repeated fears about their homes.

*It would be like putting your bed in the basement. I'd hate all that gloom and dark.*

"There is more light in our under-

ground house than in any other house we've owned," says Dona Scafe of Independence, Mo. "In winter, sunlight penetrates 14 feet through our glass-fronted south wall."

Lee and Sandra Bull live in a Kent, Ohio, earth-sheltered house in which sunlight fills a 20×20-foot open atrium in the center of the structure.

"Daylight just pours into our home," says Lee. "It's more than we've been used to before."

In Texas, another underground family praised their atrium. "Because the atrium is private, we never cover the glass walls. It's almost as bright as living in the middle of a prairie. Our old house was always darker, because we were forever pulling down shades and drawing draperies in order to maintain our privacy."

### 'It's not like a cave!'

Don Metz, a Lyme, N.H., architect specializing in underground housing, and living in a home of his own design, says his preteen children have led class tours through the house to prove they didn't live in "a woodchuck burrow." When the youngsters' classmates reached the house, comments were in the category of "Wow!", "This is neat!", and "It's not like a cave at all!"

*An underground house would be damp and musty all the time.*

Before the wave of underground house construction began five years ago, architects warned there would be a moisture problem during the approximately two years it takes for concrete to cure thoroughly. What actually happened?

"I'd have to admit we were worried about the house being damp," says Bill Alcorn, owner of a Metz-



Beamed ceiling (left) adds warmth to sod-covered home of Oliver Winston in Lyme, N.H. Swimming pool (above) adjoins sun-collecting landscaped area in front of structure (below).

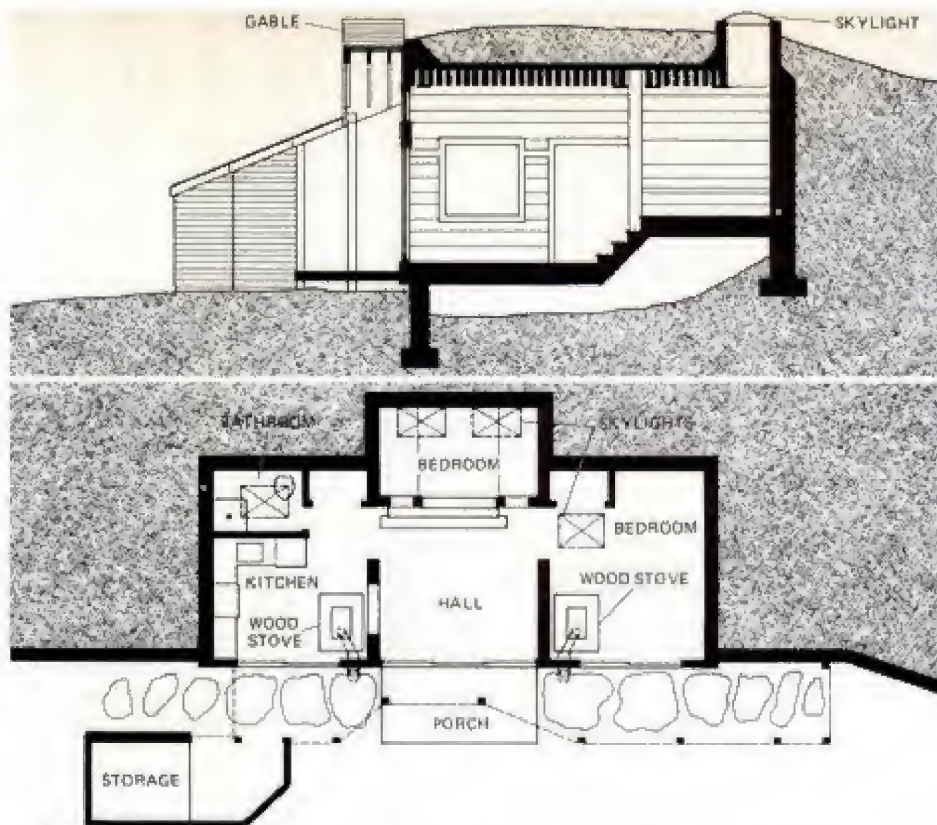






Photo: Robert Benson

Architect Mark Simon designed Washington, Vt., Crowell house (above and right) to notch into mountainside. Springs uphill supply water; stoves and sun give heat.



designed earth-sheltered home in Biddeford, Me. "But we're happy to report the house is not damp. We have absolutely no problem with mold or condensation, and the relative humidity ranges around 50 percent with no help from a humidifier—just about perfect winter and summer."

"Before moving into our underground house," recalls Lee Bull, "I always had an allergy problem relieved only by a humidifier in winter. In our new house, we have no humidifier and I have no allergy symptoms. Sandra and our four children (ages 3 to 16) agree it's the most comfortable house we've lived in."

#### Potential problem: condensation

Jean Giannesini and his family

live in a hillside earth-bermed house in Valbonne, France. It's one of the two constructed to date by Architer-  
ra, a French company planning to develop underground subdivisions in Europe and the United States. He reports, "The countryside is very damp here. Yet, we have not experienced any problem with excess moisture, although that may be due to our system of continuous air circulation."

Air circulation may be a key to eliminating an annoying side effect of concrete curing: condensation on interior glass surfaces, according to architect Metz.

And some underground homeowners wring out summer air with a dehumidifier. "We moved into our earth-sheltered house in March

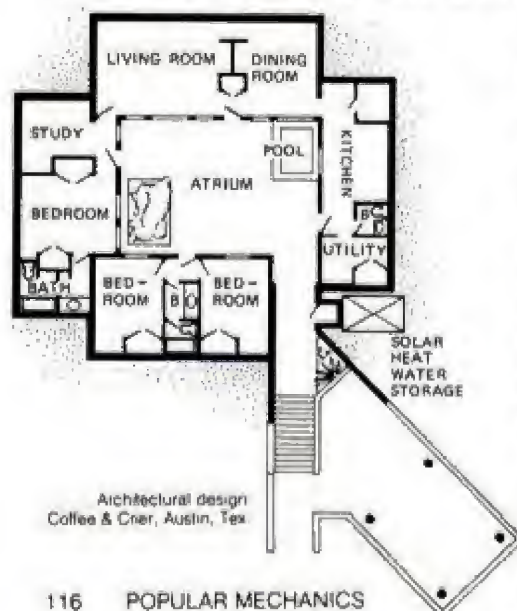
1979," says Rod Ford of Hopeville, Ohio. "It was built on a concrete slab with concrete walls and roof. I know that's where the excess moisture is coming from, and we do use a dehumidifier in the summer."

Will that moisture hang in the air after the concrete is cured? Not according to Oliver Winston, who has lived in a Lyme, N.H., earth-sheltered house for eight years. "In fact, we put in a humidifier to keep up the relative humidity for my wife's grand piano."

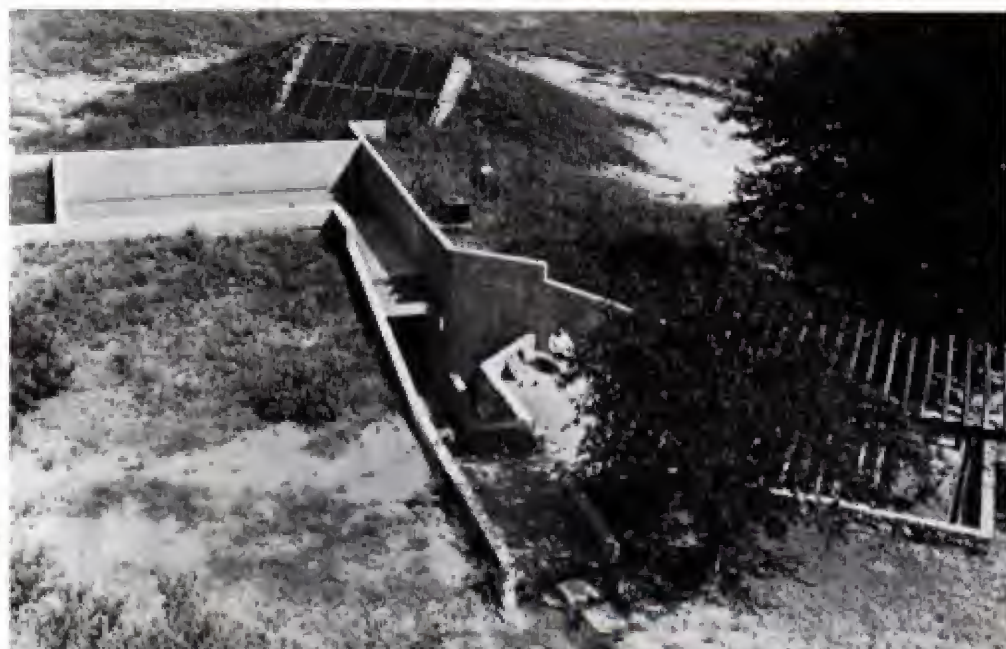
*Who wants to stare at the sides of a cave? I've got to have a view from my house.*

Joan Crowell and her family vacation in a mountainside house in Washington, Vt., that was planned by her son, Mark Simon, of Moore,

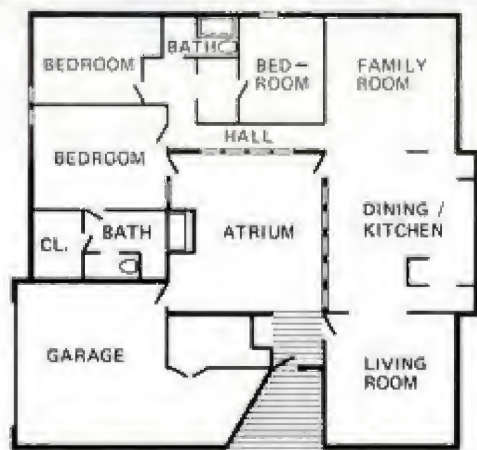
Rooms in Texas home face central atrium (below, left). Solar collectors (at top of photo below) are on berm north of house.



Architectural design  
Coffee & Crier, Austin, Tex.







Lee and Sandra Bull and their four children live in this Kent, Ohio, house. Bull reports his allergies disappeared after moving underground.

Groves & Harper in Essex, Conn.

"The house is an extraordinarily exciting experience," she says. "It's like being the eye of the mountain. We look down on other peaks, and at times the view is like a Chinese landscape painting because the clouds are very close."

Many of the families interviewed live in homes with great bands of glass facing a pleasant view southward. What of those living in atri-

um-styled underground houses?

They like the view, too. Lee Bull reports: "Why would we want to look out on a lot of dirty slush in the winter? Our glass-covered atrium is filled with greenery all year. I'd much rather see blossoming orange or fig trees in the morning than a stand of bare-leaved trees."

The Texans (who preferred anonymity) living in a similar house said, "What view? A big commercial laboratory is going up right in front of us, since our part of Texas doesn't have any zoning regulations. We couldn't care less about missing that. Otherwise, the land around us is flat and filled with grasses."

#### Build on a junk lot

"On a small lot, you can landscape your own view," says Dona Scafe, "but more than that, you can plant a garden or lawn over your house. In fact, one of the neat things about underground houses is being able to build on a junk lot, like one right next to a freeway."

Architect Malcolm Wells, Brewster, Mass., in the forefront of underground housing since its renaissance began, is an advocate of the science for many reasons. Not the least important are his strong feelings about returning scabby lots, asphalt paving and gravel no-man's land to natural sites where green plants can once again enter the carbon dioxide/oxygen cycle.

*Ever smell vegetables rotting in a*

*basement bin? Living underground would give us fits over odors.*

Not one family in our survey cited odors as a problem. Some had ventilating equipment in the baths and kitchen. Some didn't. But the fact is, underground houses go through about the same air changes as a well-insulated above-ground house.

#### A few crickets and spiders

*Rats and mice have a field day in our basement. Can you imagine living with rodents and bugs?*

### 'Our atrium is filled with greenery all year.'

"Since our house is three-quarters underground, we thought we might have to battle insects when we moved in," recalls Lloyd Remington of Asheville, N.C. "But we have almost none—quite a change from our Florida house, where we took insects of all kinds for granted. We haven't any screens over our glass doors because there aren't many mosquitoes or flies in Asheville. When we open the doors in summer, we gather in a few crickets and one or two spiders."

James J. Brown, president of Underground Homes, Portsmouth, Ohio, is unequivocal. "An underground home built properly of concrete will never have an invasion of flying insects, termites, rodents or reptiles," he says.

Experience seems to bear up a

(Please turn to page 240)



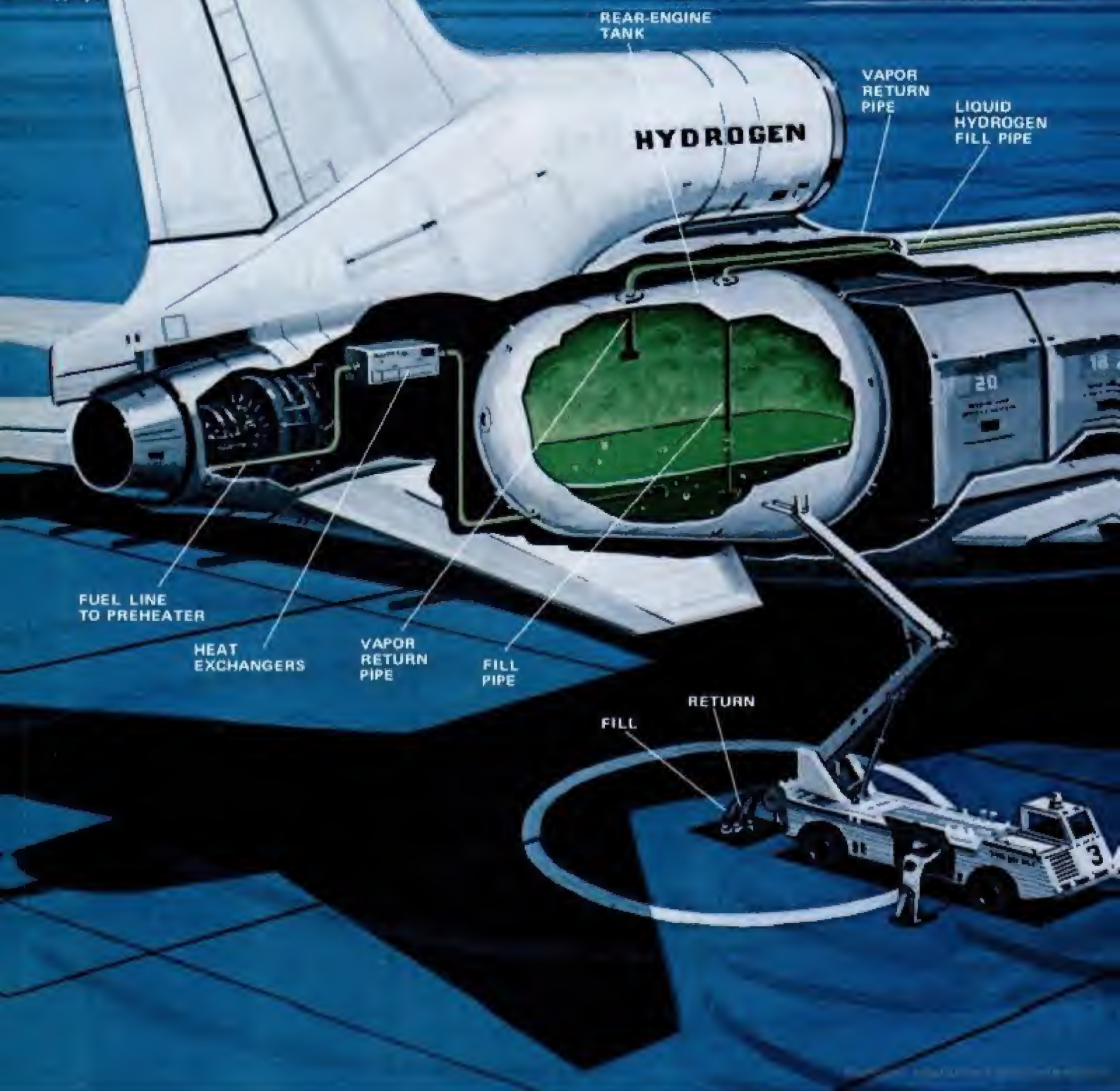
Daylight from atrium brightens interior.



# Hydrogen: new kick for cargo planes

Our strongest ally in fighting OPEC prices might be the lightest element—the best fuel water can provide.

by Tom Johnson





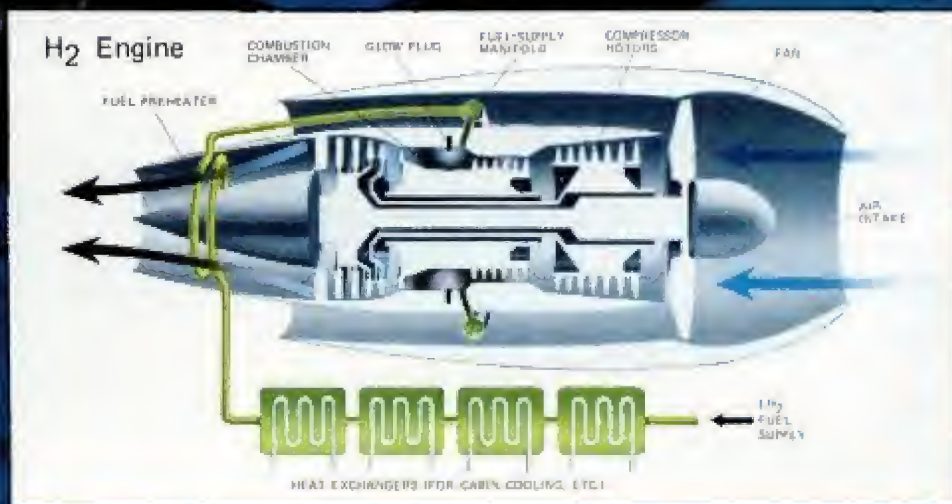
**T**he ground crew scrambles to jam the last few tons of cargo into the bay of the Lockheed L-1011. Gaping doors swallow the final pieces: four skids of machine tools and two limousines, part of a huge but workaday load for the 186-ton plane.

But this is no ordinary plane. For one thing, it is 35 feet longer

than the standard L-1011, to make room for fuel tanks in the fuselage instead of the wings. And in these tanks, feeding the three Rolls-Royce engines as they haul the giant plane toward the sky, is the lightest element on earth, the best fuel water can provide: pollution-free, safe—hydrogen.

A hypothetical account? Yes.

But it's a fantasy moving quickly toward reality. If the efforts of Lockheed, NASA and a half dozen nations prove out, that cargo plane will be lifting off the runway before the end of the decade. Every time the Organization of Petroleum Exporting Countries (OPEC) bumps the price of oil a nickel a barrel, or another explora-







Theoretically, hydrogen-powered passenger plane could carry 234 at cruising speeds around 2000 mph. Range: 4200 miles.

tory well comes up a duster, hydrogen-powered aircraft—to say nothing of cars, home appliances and steel-mill blast furnaces—make more sense as a means to escape petroleum dependence.

### It's simple: Hydrogen is light

In many ways, hydrogen is a dream fuel. Raw materials for producing it—natural gas, oil, coal or coal dust, even water—are available around the world. Sensibly handled, hydrogen—especially in liquid form (LH<sub>2</sub>)—is safer than most petroleum fuels, except diesel oil.

There are only a couple of "pollutants" resulting from the combustion of hydrogen. One is nitrogen oxide, from burning the nitrogen in air. But this results from burning any jet fuel. The other is water vapor. (A hydrogen-fueled auto engine tested a few years ago emitted exhaust that was cleaner than the air over Chicago streets.)

Best of all, hydrogen releases more heat energy per unit of weight than any other hydrocarbon fuel. Liquid hydrogen is not only lighter

than the top grade of jet-engine fuel (a cubic foot of LH<sub>2</sub> weighs 4.4 pounds compared to 51.6 pounds for jet fuel), but the hydrogen produces 2.8 times more heat (B.T.U.s) per pound. And anything that reduces a plane's fuel load while delivering more thrust per pound of fuel off the runway can set aeronautical engineers like Lockheed's Dan Brewer thinking and tinkering.

"In the early '70s, it was already apparent (that) the peak of crude-oil production in the world would be reached in the mid-1990s," Brewer said in his Lockheed-California office in Burbank. "But before the crisis point is reached, it is imperative for the air-transport industry that development work be completed on a suitable alternate fuel for advanced-design aircraft."

Brewer was not alone in his thinking. NASA began sponsoring research into a variety of fuels to replace that 6 to 10 percent of each barrel of crude oil that is used for high-energy jet fuel. "As a result of these studies," Brewer said, "liquid hydrogen has been shown to be an

outstanding candidate fuel for use in transport aircraft of the future."

Designing that transport of the future—and thinking about the problems of producing, delivering and storing LH<sub>2</sub> at the airports—has been Brewer's assignment for the past eight years. Slowly, other engineers, airline officials and nations joined his dream.

Last fall, 120 representatives from 14 nations meeting in Stuttgart, Germany, enthusiastically agreed to participate in a coordinated research effort to test the practicality of LH<sub>2</sub> aircraft. If, after 30 months of study, the numbers and bench tests fulfill expectations, the plan calls for the startup of an experimental airline.

### Airborne by '87?

Aircraft, hydrogen production plants, and storage and fueling facilities at airports would be built for an estimated \$1.3 billion—the cost shared by at least five or six participating nations. Ultimately, a two-to four-plane cargo line flying between cities such as Pittsburgh, Frankfurt, Riyadh, Saudi Arabia, and Birmingham, England would be airborne by 1987 or 1988. (These cities dispatch large quantities of air cargo, and either coal or natural gas is readily available in each to manufacture hydrogen. In fact, much of the natural gas in Saudi Arabia is currently burned off as a waste product.)

Fortunately, most of the nonaircraft technology needed for the project is already known. More than 20 million tons of hydrogen were manufactured and transported by trucks or pipeline in the United States last year. West Germany has nearly 200 miles of pipeline devoted to hydrogen, a fuel generally in wider use in Europe than in North America. Storage systems for liquid hydrogen have been used safely for more than 20 years by the space program.

Major design and development work, however, will fall to the aircraft companies. Lockheed's design

## HYDROGEN VS. KEROSENE: WHICH IS SAFER?

POTENTIAL PROBLEM	HOW HYDROGEN WOULD BEHAVE	HOW KEROSENE (COMMON JET FUEL) WOULD BEHAVE
Flammability.	Ignition temperature is high, and if hydrogen ignites it burns rapidly with little radiation and no smoke.	Ignition temperature is low. High radiation, dense and noxious smoke accompany burning.
Human contact with fuel.	Drops of liquid hydrogen turn to gas quickly, causing no damage to human skin. Vapor itself is not toxic. Large amounts of liquid hydrogen have the potential to freeze and destroy tissue.	Kerosene causes little skin irritation. Vapors are toxic.
Contamination from spill.	In air, hydrogen dissipates quickly after vaporizing. Fuel spill would cause no lasting contamination.	Heavier-than-air kerosene would settle toward ground, contaminating area around spill.
Contamination of fuel itself.	Liquid hydrogen does not support growth of organic contaminants because it is stored at low temperatures.	Standard jet fuel is easily contaminated with organic and inorganic substances.
Danger of explosion.	Low, if tank is intact. Stored hydrogen lacks oxygen necessary for detonation.	Kerosene tanks in aircraft contain both fuel and air. Heat can set off explosion.
Temperature increase.	Hydrogen expands with increasing temperature. Pressure from expansion can rupture tanks without adequate venting mechanism. Constant refrigeration or adequate insulation is essential.	Kerosene undergoes little expansion with increasing temperature—a safety plus for conventional fuels.



is the most advanced to date, primarily because it utilizes wing, tail, engine, crew-compartment and landing-gear components already proven on the L-1011 TriStar.

"The fuselage diameter is standard, but the length would be increased about 35 feet to permit fore-and-aft LH<sub>2</sub> fuel tanks," Brewer said. This placement minimizes shifts in the plane's center of gravity as fuel is consumed.

Elimination of conventional wing tanks also cuts down the surface/volume ratio of the fuel-storage tanks, making it easier to keep the fuel at cryogenic temperatures. Liquid hydrogen will be maintained at minus 423° F. by use of a 3- to 3.5-inch insulation sandwich around the tanks with just enough "give" to stand the normal vibrations and stress of flight. If air—typically laden with water vapor—hit a tank wall, frost would build up and the freeze-thaw cycle eventually would crack most insulations. Another novel aspect of the tanks is that they will be an integral part of the airframe instead of the usual separate fuel "containers" to be found in most aircraft.

"Not only will the tank design give more strength with less weight," Brewer said, "but if an insulation crack should develop, it will be easy to spot. Frost will build up on the outside of the plane."

### Capitalizing on the cold

Keeping the fuel cold does add some design problems. But Lockheed designers are trying to turn the frigidness of the fuel to their advantage. Cooling the outer skin of the wing, for instance, might smooth the airflow over the wing and fuselage, improving flight performance and saving fuel. Preliminary research indicates that if air passes over an extremely cold surface, it flows much more smoothly.

Lockheed's design calls for using LH<sub>2</sub> to cool an intermediate fluid—gaseous nitrogen seems a likely candidate—which would then be circulated through special channels in the aircraft's surface to reduce the skin temperature to roughly minus 180° F.

Up to now it's just a theory, but engineers estimate that by cooling the engine nacelles, 75 percent of the wing surface and the forward 20 percent of the fuselage, the effect could save as much as 21 percent in direct operating costs because of increased in-flight efficiency.

"Because the cold aircraft skin would freeze water vapor in the air, this system of laminar flow control would only be used above 25,000 to

30,000 feet, where moisture content is not significant," Brewer told the delegates in Stuttgart.

The cold hydrogen will also improve engine efficiency. After the liquid hydrogen leaves the fuel tanks, it will flow through heat exchangers. These enable the fuel itself to take on major cooling jobs—keeping engine-oil temperatures down, for instance—even helping to aircondition the cabin on the ground.

### H<sub>2</sub> warms itself

Finally, the hydrogen will pass through a heat exchanger mounted in the engine exhaust. There, the 1800° F. exhaust will bring the fuel up to 761° F. just before it is injected into a combustion chamber, where conventional glow plugs ignite it. Although it will approach the injector at a high temperature, the hydrogen will remain a liquid up to that point because it will be under high pressure—750 pounds per square inch (p.s.i.). Because the hydrogen is heated, it will vaporize faster for a

greater combustion efficiency.

The heat-transfer units will fit easily into the pod of the Rolls-Royce RB 211-22B engines with minor modifications. "All four of these heat exchangers on each engine will only weigh 240 pounds," Brewer said, "and their use will reduce fuel consumption by about 8 percent."

The energy advantages, while impressive, are only part of the savings anticipated by the designers of hydrogen-powered aircraft. For one thing, the comparatively low weight of the fuel reduces the overall weight of the plane. And that in turn cuts construction costs, by about 3 percent. And as traditional petroleum fuel prices escalate, the cost advantage of LH<sub>2</sub> will increase as well, Brewer believes. He would not be surprised, he told PM, if the per-mile cost of a hydrogen-powered plane with laminar flow cooling is half that of conventional jets by the end of the decade.

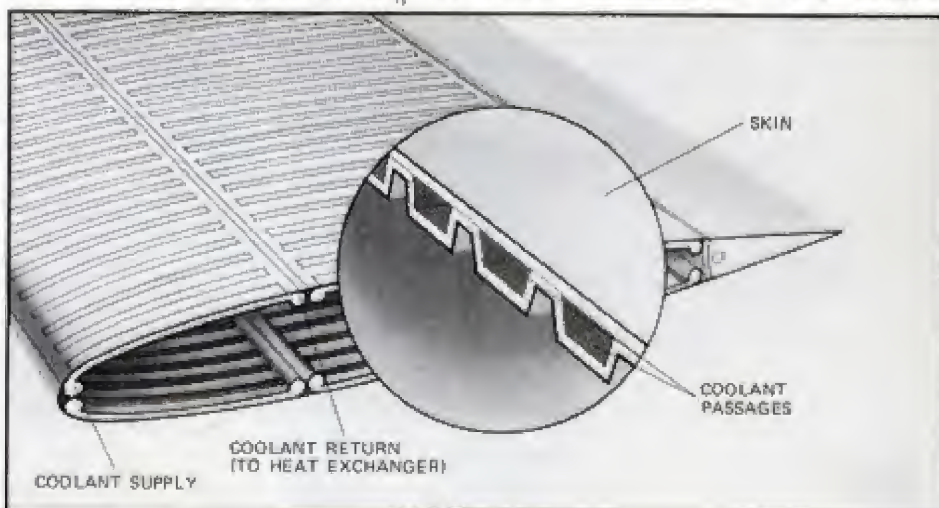
Researchers outside of Lockheed are inclined to agree that hydrogen

*(Please turn to page 244)*



Four-engine subsonic hydrogen plane could carry 400 passengers seated on two decks.

Lockheed design calls for cooling the wing surfaces at high altitude to improve air-flow and cut friction. Liquid hydrogen fuel would chill coolant, probably nitrogen.





**F**or a newly introduced car, the Toyota Tercel is considered one of the best built and best crafted automobiles we have ever surveyed. Owners are nearly unanimous in their praise of the Tercel's workmanship, ride, handling and comfort.

For example, 81.2 percent of our respondents told us they had no trouble of any sort, either major or minor. And 92.8 percent rated their cars' workmanship good to excellent.

A Michigan mechanical engineer had this to say about his Tercel: "It's very well put together—from the front-wheel drive to the rear seats to the fuse box."



Styling attracted 16 percent of buyers, but some feel rear looks too chopped off.

Economy ranked as the No. 1 reason for purchase, with 72.7 percent listing it as their primary buying goal. Virtually the same number gave economy as the fea-



ture they liked best about their cars. "To find out about gas mileage," volunteered a North Carolina hosiery inspector, "we've checked every tankful so far for 4500 miles. The lowest has been 29.9 mpg, the highest 37.2, with an overall average around 32 mpg."

That's about par for the car, but ironically drivers with four-speed gearboxes got exactly one mpg better gas mileage than those with five-speeds. Ratios in these two transmissions are identical, except that the five-speed has an 0.825:1 overdrive high. Fourth is 1:1 in both. We suspect that five-speed owners might be using fifth gear around town and lugging the engine. Fifth is really intended only as a highway cruising gear.

A few owners complained of hard shift-

ing between second and third gears in cold weather. "It's also sometimes hard to get into reverse," grumbled an Oregon teacher. And the few complaints we heard about lack of engine power came from drivers who'd opted for the automatic transmission.

Most owners praised the Tercel's handling and its front-wheel drive. An Ohio educator told us, "My car handles very well, especially in the snow and on slippery roads."

A Vermont assistant administrator said, "Love that front-wheel drive! Here in Vermont the winters are tough. This is the first car I've ever had that hasn't skidded and slithered in the snow. It handles well."

Even so, we did note some complaints on road noise. "I think the engine is a bit



Tercel uses rack-and-pinion steering, gearers praise for comfort and roominess.

BY MICHAEL LAMM WEST COAST EDITOR

## It's built beautifully and gets good gas mileage, but the shifter balks in cold weather



Good vision results from tall greenhouse, large windows.

Front drive aids winter handling. Engine rests lengthwise.

Toyota might add four-wheel drive to future Tercels.



loud out on the highway," admitted a Tennessee school teacher. A Wisconsin doctor suggested, "They ought to put in more sound insulation. The car is too noisy at high speeds."

Our respondents were very pleased with the Tercel's roominess and comfort. "Friends who own Citations and Phoenixes are impressed with my Tercel's seats and legroom," beamed a New York corporation executive. A New York engineer confided, "I drove to Florida and back on a vacation recently. The car was very comfortable driving 12 hours a day." Here's one car that accommodates adults in the rear seat. A Nebraska student smiled, "I have very long legs and can sit comfortably in the front or rear."

Tercel owners spoke relatively well of their dealers, with 68.8 percent marking the service department *good to excellent*. That's lower than Cadillac and Oldsmobile, but considerably above Chevrolet, Ford, Plymouth, Dodge, Pontiac and many of the imports.

"I haven't had to bring my Tercel in for service although I now have over 10,000 miles on the car," wrote a Tennessee computer operator, "but I've owned Toyotas before and know the dealer's service is good."

On the other hand, "I got the runaround even on minor items," said a Wisconsin foundry worker.

As for suggestions to improve the Ter-

cel, we received the following. "The sedan needs a longer trunk," noted a South Carolina student. "It looks like someone chopped it off."

"How about a four-wheel drive option?" asked a Wisconsin grinder. We're pleased to report that Toyota, too, is mulling over this possibility. One thing about the low transaxle is its adaptability to 4wd.

"Serviceability in the engine compartment ought to be improved," recom-

*(Please turn to page 252)*



Sedan's trunk is 9.3 cu. ft. With seats folded, Liftback gets 34-cu.-ft. capacity.

## Toyota's new Tercel

Launched last November as Toyota's first front-wheel-drive car, the Tercel marks this importer's price leader at \$3698. It's also Toyota's economy champ, turning in an EPA-estimated 30 mpg overall.

Toyota calls the Tercel the base model of its Corolla line, yet the two share no body panels and very few mechanical components.

The Tercel was engineered by Toyota's managing director, Tatsuo Hasegawa, who chose not to follow traditional fwd minicar practice. Instead of positioning the engine crosswise, Hasegawa pointed it north/south, with the gearbox aft and below, and the final drive just beneath the rear cylinders. This makes for a tall power unit, but Hasegawa held the engine to a short 21.6 inches by using Siamese bores. The main advantage, he says, is engine accessibility, which indeed does suffer in most sidewinders.

The Tercel boasts a new 1452-cc, sohc, 60-hp Four with an aluminum head and cast-iron block. The head contains small, built-in "pots" or swirl chambers that create turbulence and reduce emissions. The Tercel does require unleaded fuel, though.

Body styles include a two-door notchback and three-door liftback in both standard and deluxe form. For an additional \$550 above the deluxe liftback, you can order the SR-5 Tercel, which includes sportier trim, five-speed gearbox, full instrumentation, larger tires, and a handling package.

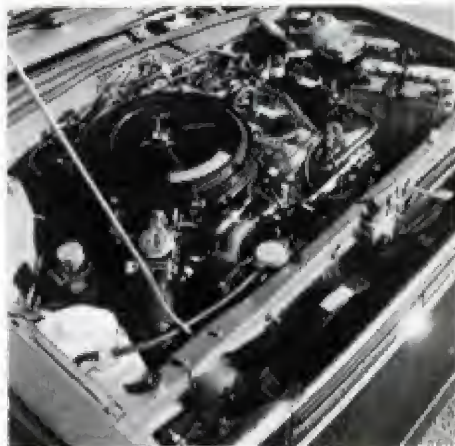
Suspension is by MacPherson struts up front and coils on semitrailing arms at the rear.

## A NATIONWIDE SURVEY BASED ON 1,124,763 OWNER-DRIVEN MILES

Tercel's other body style, a liftback, has 50/50 folding rear seats.



Sedan's trunk capacity is 9.3 cu. ft. Gas tank holds 11.9 gal.



Sixty-horse Four sips unleaded fuel, gets better mileage with four-speed than five. Distinctive rear styling makes the Tercel easy to recognize.

Tercel is 5 inches longer than Rabbit, yet weighs 77 pounds less.



# New little mills— more boating on less gas

Economical mini-outboards could become big favorites afloat if a gas crunch comes.

by Bill McKeown BOATING EDITOR

Even a 21-footer can be pushed right along with a 7.5-hp Mercury, PM's McKeown finds, during an upper Amazon dugout boat test.

**T**his should be a big year for the little motor. These are the lightweight, compact kickers that used to be the favorites of fishermen and dinghy owners, and the push-power for reluctant kids who dreamed of steering the bigger muscle machines. Now oil and the economy are changing our thinking.

Fortunately, a new look at the mini-motor league shows many major improvements. For the last few seasons, developments in speed and reliability, ignition and carburetion that have been tested on the race course have been incorporated in the big stock-production machines and then moved right down the line to the smallest of the clamp-ons. Many outboards of 25 hp and under now can perform with remote steering, forward and reverse shift, capacitance-discharge ignition, water cooling, and some now brag of auxiliary fuel tanks. These are the marine powerplants that are truly portable, as well as the most economical and convenient around. Weight and even price per horsepower have gone down if you figure in inflation.

## What's available: models and makers

In the little leagues, there are also more models to choose from. All the big outboard manufacturers supply low-horsepower motors, and there are a number of other well-known builders, as well. If you wanted a 300-horse mill, your only choice would be a Mercury right now. Drop down to motors of 25 hp or less, however, and there are at least 18 names to choose from. Alphabetically, they include:

- AquaBug, with 1.2 horses from 11 pounds and SuperBug, weighing in at 21, come from Aquabug International in Rockville Centre, N.Y.
- Carniti, the only diesel outboard, is imported from Italy in 6- and 16-hp models by Pennsylvania Development Co., North Versailles, Pa.
- Chrysler goes up to 140 hp, but has a batch of minis at 4, 6, 7.5, 9.9, 15 and 20; some have electric-start. They're built in Hartford, Wis.
- Clinton is well known for its small motors and has eight models with hp ratings of 2, 3.5, 5.5, 7.5 and 9. Clinton Engines Corp. is in Maquoketa, Iowa.
- Cruise 'N Carry is a dinghy and canoe motor weighing only 12 pounds that cranks out 1.3 hp. It comes from HMC, Torrance, Calif.
- Eska, another famous small-motor name, has 3.5, 5, 7.5, 9.9, and 15 hp, some offered in standard or deluxe models. The Eska Co. is in Dubuque, Iowa.
- Evinrude, the company that started it all when it mass-produced an outboard for everyone, now has



Among the most versatile of craft is a well designed dinghy. This Boston Whaler ferries passengers with a 4.5-hp Evinrude.

horsepower options of 2, 4, 4.5, 7.5, 9.9, 15, 25 and many more. The last three mentioned come with manual or electric starting, and power options go on up to 235 for the biggest of these models from Milwaukee.

■ Honda has two 7.5 and two 9.9 two-cylinder models. They are imported by American Honda which is in Los Angeles.

■ Johnson started out with light aluminum airplane and bicycle motors. This year's pony-sized Sea-Horse outboards have a lot of kick for their light weight and, like Evinrude, come in 2, 4, new 4.5 and 7.5, 9.9, 15, 25 and on up to 235 hp. Johnson is headquartered in Waukegan, Ill.

■ Mariner, a cousin of Mercury in Fond du Lac, Wis., makes 2, 3.5, 5, 8, 9.9, 15, 25 and up to 200-hp models.

■ Mercury, with about 54 models in all in its run up to the 300-horse line leader, starts with a 3.6 hp in short and long shafts, 4, 4.5, 7.5 with optional electric start, 9.8, 18, 20 and 25 hp.

■ Mighty-Mite II, from Mighty Mite Marine in Old Lyme, Conn., gets 2 hp from 17.5 pounds.

■ Montgomery Ward Sea King engines from Chicago will come in at 2, 3.5, 4, 5, 7.5, 9 and 15 hp.

■ Seagulls, the old reliables from England, are again in 2, 3, 4.5 and 5.5-hp models.

■ Sears, Roebuck starts down at 1.2 hp for its models and runs through 3.5, 5, 7.5, 9.9 up to 15. Several are





Photo: John Willard



Low center of gravity and high performance of inflatables like a Zodiac that has a 25-hp Johnson can handle offshore waters.



Grumman's 4.6 aluminum 15-foot Sportsman is rated for up to 40 hp, but it's light enough to perform well with a 9.9 Evinrude.



Even the push from a 4.5-hp Johnson is enough to plane a Boston Whaler inflatable. More muscle could provide ski speeds.

offered in short and long shaft lengths by the Chicago company.

■ Spirit outboards from Arctic Enterprises, Thief River Falls, Minn., and Suzuki Int., Santa Fe Springs, Calif., both have little models of 2, 3.5, 5, 8, 9.9, 16, 20, 25 and on up to 85.

### What they can do

Unless you own a new little late-model motor or have tested one recently, you may not know what a few two-cycle stallions in a tiny package can turn out. With care, you can go almost anywhere a larger mill could push you—just not as fast. Instead of twin engines, many outboard sports fishermen and cruisers are switching to one engine for primary power and a small one in case of emergencies. Less weight, gas and expense are among the benefits. We've seen small children water ski behind a 4.5 on a light aluminum hull, and fishermen for many years have known the advantages of all-day trolling on one tank of gas.

But hefty hulls can be handled by the compacts, as well. We recently test-drove some heavy dugout canoes at the famous El Dorado fishing resort in the jungles of Colombia. You don't plane a 20- or 30-footer with 7.5 hp, but the native craft could carry huge loads or speed fishermen at about 10 knots out to where some of the world's hungriest fish were waiting.

PM

All under 50 pounds in weight, eight Clinton models range from 2 and 3.5 hp to 5.5-, 7.5- (shown) and 9-hp compact models.





Small improvements may equal big future economies afloat, this famous designer claims.

# New shapes for

by Jim Wynne

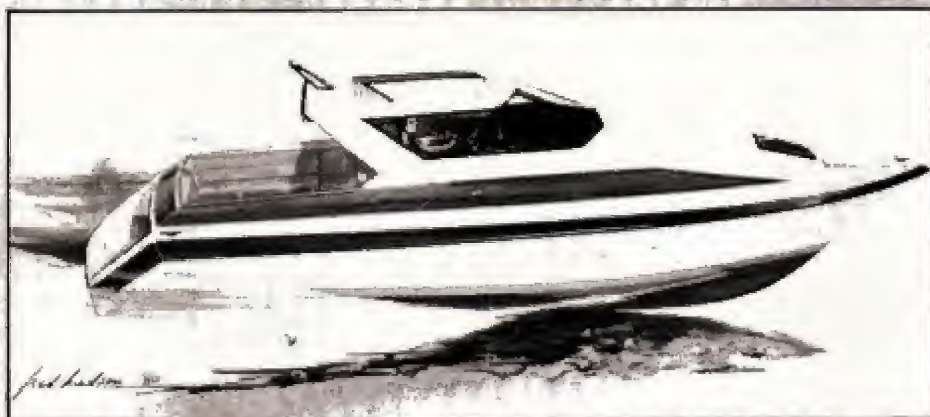
**E**nergy—a key word in everyone's vocabulary during the 1970s—promises to be a most dominant factor in boating in the '80s. Just as the cost and availability of fuel have radically altered the cars we drive, many changes appear inevitable for pleasure boats, as well.

Most powerboats in use today, whether small fishing boats, runabouts or cruisers, share a design concept known as the planing hull. The shape of the bottom, combined with the boat's forward speed, produces an upward or lifting force which allows the boat to rise and "plane" on the surface of the water. Throwing a flat stone so it skips across the water is a simple example of planing.

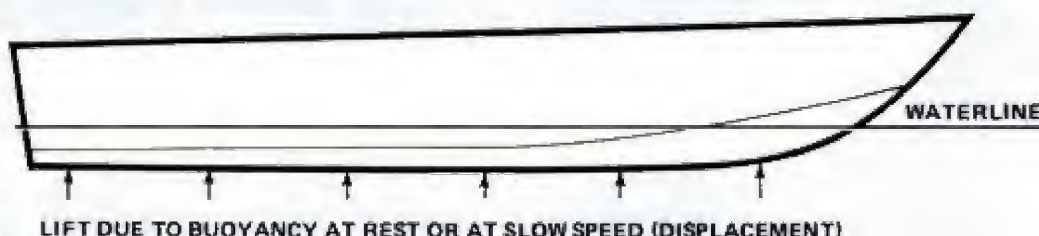
At rest, a boat floats due to a buoyant force or lift which is equal to the weight of water displaced by the volume of hull below the surface. Boats which operate slowly, or have a bottom shape which doesn't produce lift as the boat goes faster, are known as displacement hulls. Hydrodynamic effects limit the speed of these boats to around 8 to 10 miles per hour. This explains why planing boats, which commonly run in the 20 to 40-plus mph range, have become so popular to cover distances in a reasonable time.

## Power for planing

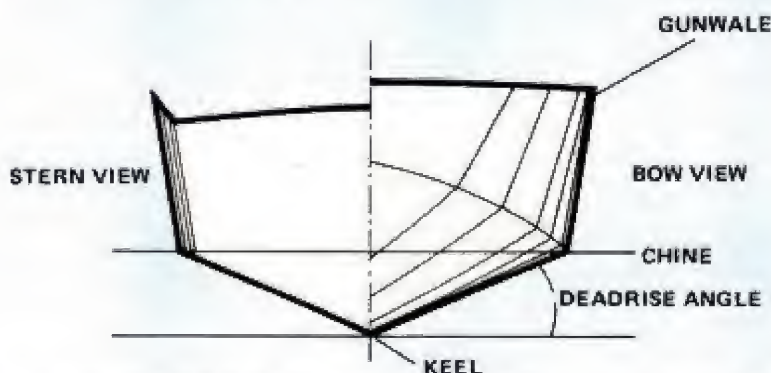
But there is a catch to this simple comparison—and it can be a big one. In order to reach planing speed and lift the boat out of the displacement range, a great increase in power is required. While some types of engines are more efficient than others, in general, the greater the speed the more power (and fuel) is required. So a first rule to reduce fuel consumption is to slow down. Actual test of several typical 22-foot sterndrive and outboard-powered boats show that miles per gallon



With slippery hull designed by author for fuel savings and soft ride, and streamlined topsides by industrial designer Fred Hudson, the new Albin 7.5 is an economy cruiser.



Typical semiflat-bottom displaces and pushes water at slow speeds, planes with more power.



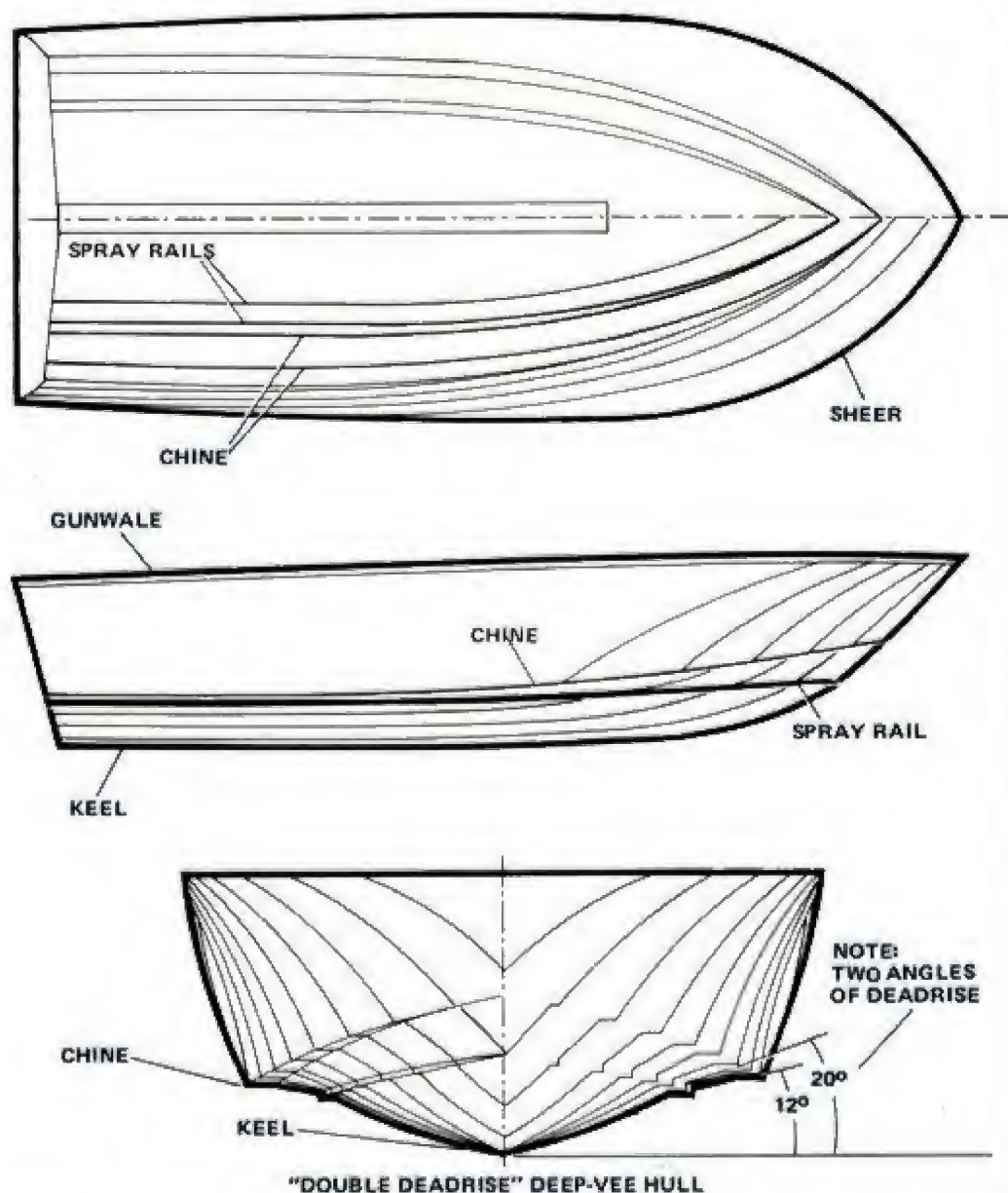
Constant deadrise planing hull lifts onto plane at speed, but cuts waves rather than pounding.



# budget boating



Testing a development model of Swedish Albin 7.5-meter hull with Wynne Marine "Propeller Pocket" and "Double Deadrise" deep vee, author runs ballasted hull in trials.



Lighter hulls, easier ride and small modifications like those shown may be ways to save fuel.

increased 40 to 75 percent when speed was reduced from about 40 to 20 mph.

Second only to speed in affecting planing-boat fuel consumption is weight: the heavier the boat, the more power required to produce the speed and lift to keep the boat on plane. An extreme example is the overloaded boat, where full engine power will never get the boat moving fast enough to plane it.

The obvious answer is to reduce weight as much as possible and remove excess gear so as to use minimum power and fuel for a given speed. Trim tabs—those small adjustable flaps extending aft of the bottom at the stern—can also help most heavier boats to plane efficiently at lower speeds (See *Trim Gas Use by Half!* page 117, Feb. '80).

New boats are now being built with more attention paid to weight, both to improve performance and to hold down the cost. Materials used in fiberglass construction come from petroleum, so their costs have gone up as crude oil prices have jumped. But reducing the amount of material in a boat has to be done very cautiously. Marine construction must withstand occasional use (or abuse) in rough water or unexpected conditions. New and exotic lightweight materials are being tried, but so far they are still too expensive for the average pleasure craft. Reducing weight in a boat is much more difficult than in a car because of the wide variety of conditions which occur on the water. The reputation of your builder is your best guaranty of quality construction.

These are the important factors affecting economy of present boats. Let's look at how new designs may improve things still more.

## Better designs can help

The most efficient boat is shaped to slip easily through the water at displacement speeds. Sailboats have been refined for years to reduce drag (and the amount of wind-power required) to a minimum. But since these hulls are limited to well under 10 mph, it's doubtful if most

[\(Please turn to page 272\)](#)



# Build a cradle with old-time charm

Choose either the hanging or standing cradle; you can make it easily for less than \$50.

by Harry Wicks HOME AND SHOP EDITOR

In a lot less time than you might suspect, you can add a touch of nostalgia to your nursery by building one of these plywood cradles. Whether you select the hanging cradle or the standing colonial type, you will have an attractive, economical and sturdy bed for your infant's first months.

Designed by Julie Beck Ockfen

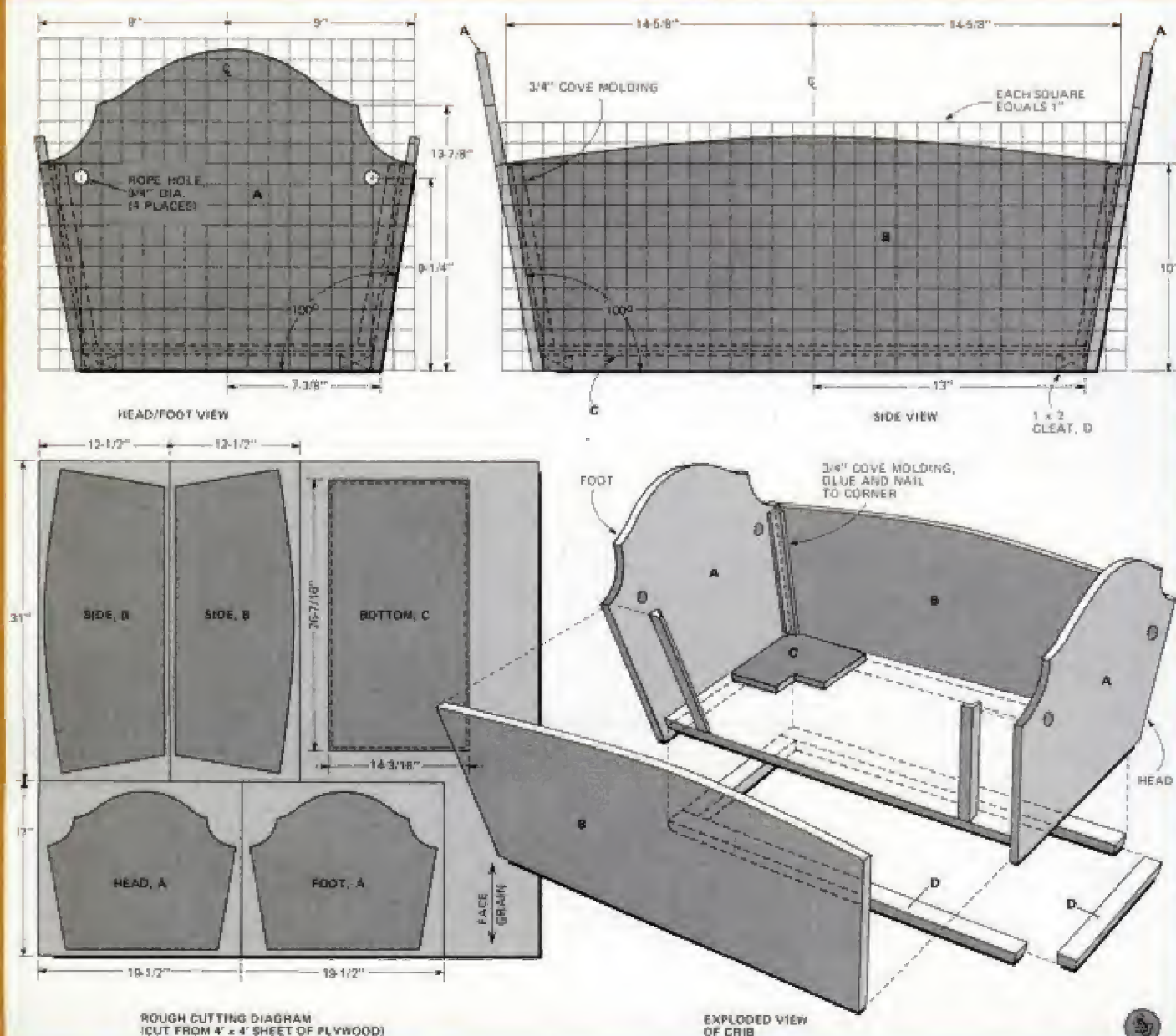
and Tom Tavernor for *Popular Mechanics* and the American Plywood Assn., these cradles will accommodate standard 13 x 28-in. foam basket pad mattresses or polyurethane foam sheets cut to size.

## General directions

Constructed of a half-sheet of  $\frac{1}{2}$ -in., APA grade-trademarked A-B,

A-C or MDO (medium density overlaid) plywood, some  $\frac{3}{4}$ -in. cove molding, glue and nails, you can build the hanging cradle easily in one shop session for less than \$40; the standing cradle takes somewhat longer to build, and costs about \$50.

■ Use a portable circular, sabre or table saw to cut the plywood pieces to size. Cut with a smooth blade and







Hanging cradle is suspended with a strong decorative cord.



Colonial type can be rocked or held rigid with dowel.

position masking tape before cutting. Put the tape on the B side and cut with the A side down with either a sabre or circular saw. On the table

#### MATERIALS LIST—HANGING CRADLE

Key	No.	Size and description (use)
A	2	$\frac{1}{2}$ x $15\frac{1}{2}$ x 18" plywood (head/foot)
B	2	$\frac{1}{2}$ x $11\frac{1}{4}$ x 29 $\frac{1}{2}$ " plywood (side)
C	1	$\frac{1}{2}$ x $14\frac{1}{2}$ x 28 $\frac{1}{4}$ " plywood (bottom)
D	4	$\frac{3}{4}$ x $1\frac{1}{2}$ x length to suit, pine or fir (cleats)

Misc.: 4 pcs.  $\frac{3}{4}$ " cove molding cut to suit,  $\frac{1}{4}$ "-dia. rope, glue, 6d finishing nails

saw, cut with the A side up. Make all curved cuts with a scroll or band-saw.

■ After all pieces are cut, check the edges, fill voids where necessary and sand smooth. Plywood faces need little sanding because these surfaces are drum-sanded at the mill. If you're working with a C surface, smooth it with belt and pad sanders.

■ If you plan to stain and varnish

the cradles, choose a cabinet-grade plywood which will have a handsome grain on its surface veneer.

■ When your cradle is fully assembled, touch up any surfaces that aren't smooth with 150-grit sandpaper. Dust the piece and wipe with a tack cloth. Apply stain and let the cradle dry overnight.

Next day, apply a coat of 2-lb. cut, water-white shellac, thinned 50 per-

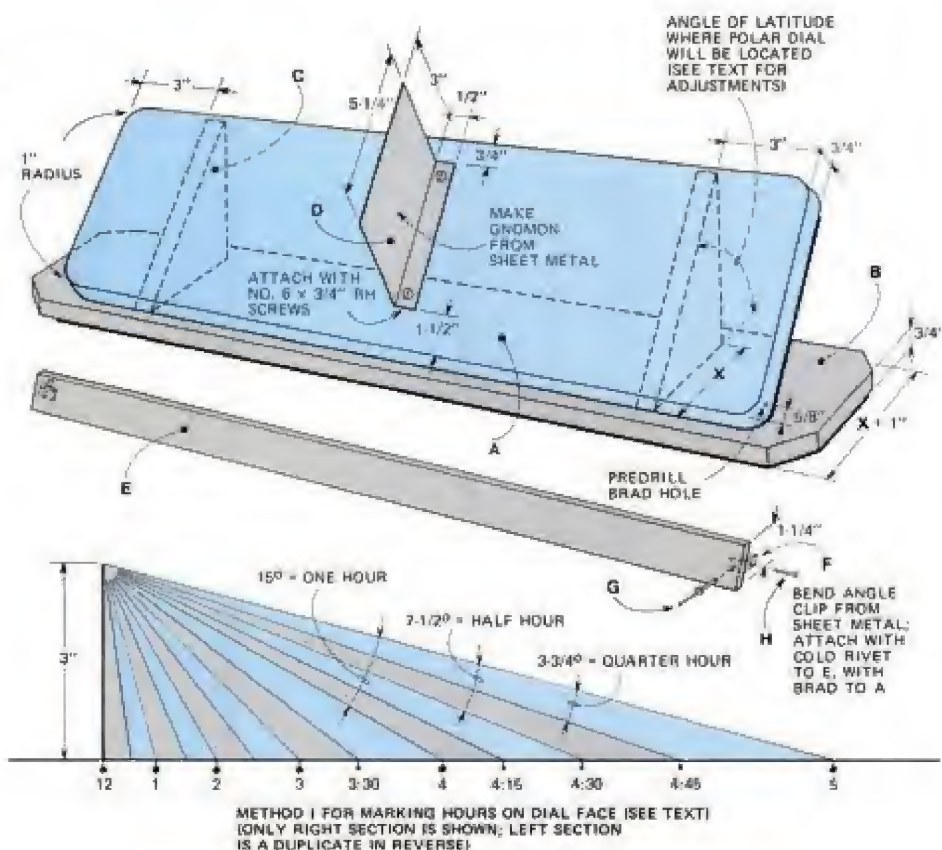
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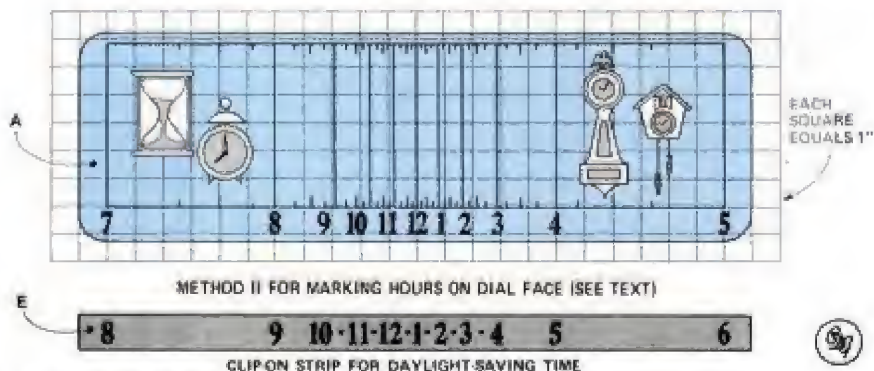
# 4 great back-yard projects



Accurate sundial is easy to build from scrap wood and sheet metal. The clip-on strip, which is shown partially removed, changes the dial to read Daylight Saving Time.



METHOD I FOR MARKING HOURS ON DIAL FACE (SEE TEXT)  
(ONLY RIGHT SECTION IS SHOWN; LEFT SECTION IS A DUPLICATE IN REVERSE)



METHOD II FOR MARKING HOURS ON DIAL FACE (SEE TEXT)

CLIP-ON STRIP FOR DAYLIGHT-SAVING TIME

## Polar sundial

Of the many sundial types used today, one of the most interesting is the polar dial, so called because the dial plate and the gnomon are parallel to the axis of the Earth and in line with the celestial pole.

To make this sundial, you should first ascertain the latitude of the area in which you live. This information is available from the local chamber of commerce, the nearest airport or from an almanac or atlas found in any library. The latitude provides the angle of the dial plate and also of the gnomon.

### Two ways to mark hours

For the most accurate way to locate hours (see plans), first draw a horizontal line on the dial  $1\frac{1}{2}$  in. from the bottom. At the midpoint, draw a 3-in.-long segment perpendicular to the horizontal line. From the top of the segment draw lines at  $15^\circ$  intervals, extending to either side. At each intersection, erect a line perpendicular to the horizontal line. These perpendiculars represent the hour lines, with 12:00 noon in the center. Bisect the  $15^\circ$  angles to locate the half-hour markings, and bisect the resulting  $7\frac{1}{2}^\circ$  angles to mark positions of the quarter hours.

For another way to lay out hour lines (which sacrifices some accuracy for ease), reproduce the markings by enlarging the grid in the plans and plotting the points. The grid method can also be used to reproduce various clock illustrations.

If you are a stickler for accuracy, consider two more factors. A sundial gives you the apparent solar time. To convert this approximation to mean solar or standard time, use the correction table which appears on page 264.

The longitude of your residence  
(Please turn to page 264)

### MATERIALS LIST—POLAR SUNDIAL

Key	No.	Size and description (use)
A	1	$\frac{3}{4}$ x $7\frac{1}{2}$ x 24" pine (dial)
B	1	$\frac{3}{4}$ x 26" long pine base (width can vary; see plans)
C	1	$\frac{3}{4}$ " pine (width and height can vary; see plans)
D	1	$3\frac{1}{2}$ x $5\frac{1}{4}$ " sheet metal (gnomon)
E	1	$\frac{1}{2}$ x $1\frac{1}{2}$ x 24" plywood (clip-on strip)
F	2	$\frac{1}{2}$ x 1" sheet metal bent into clip*
G	2	cold rivet*
H	2	1" brad (pin for clip-on strip)

\*Clip-on strip for Daylight Saving Time can also be made from a  $1\frac{1}{2}$  x 26" strip of sheet metal. Bend ends to form clips.



## Installing a lawn sprinkler system

**A**n in-ground watering system will help your lawn's appearance and free you from lugging around sprinklers and hoses. To make it easy on your budget, you can plan the entire system, but install only part of it at a time.

The operation of a sprinkler system depends on adequate water pressure (at least 40 pounds per square inch), and on the volume of water available where you tap into the existing supply line, measured in gallons per minute (gpm).

To learn how much pressure there is in your system, check with the water company. If still in doubt, obtain a pressure gauge, attach it to a faucet and take a reading with all other faucets turned off.

Volume can easily be measured if there is a faucet near where you intend to connect to the watering system. Just count the seconds it takes to fill a 3- or 5-gallon container when the valve is wide open. Divide the total seconds into the container capacity in gallons and multiply by 60 for the gpm rating. The closer your connection is to the water meter, the greater the volume to the system.

If there is no faucet near the planned connection, find out how much water will be available at that point from tables furnished by sprinkler-system suppliers.

### Plan balanced system

Even if you'll install only part of the system at a time, it's best to plan the full layout so you'll end up with a well-balanced system.

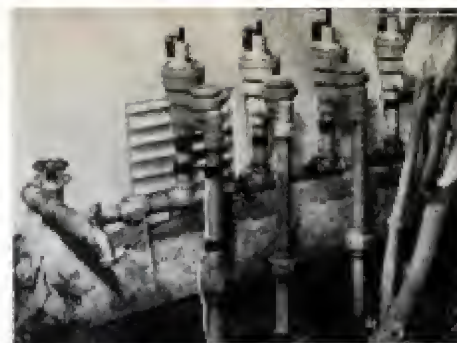
First, draw a yard plan on graph paper to a scale of 1 in. = 10 ft. Next, decide on the appropriate sprinkler heads (see drawing). Use bubblers or flat sprays for shrubbery or flower beds where overhead sprinkling is not desirable.

Now, with a compass locate the sprinklers in lawn areas based on their recommended coverages. Allow for a 2- or 3-ft. overlap to insure full coverage. Check for blind spots behind trees or bushes.

Next, obtain the gpm requirement for each sprinkler type from the maker's specifications and divide sprinkler heads on the plan into groups. The total gpm requirement for each group should not exceed 80 percent of the total gpm available at the point where the sprinkler system connects to the water supply. Try not to include lawn-sprinkler heads in the same group as shrubbery heads; each have differing watering requirements.



Check out system above ground for leaks and coverage. Then bury lines in V-shape trenches 8 in. deep. Replace sod, tamp.



Space manifold control valves at least 6 in. apart to allow room to turn the valves when you connect them to the risers.

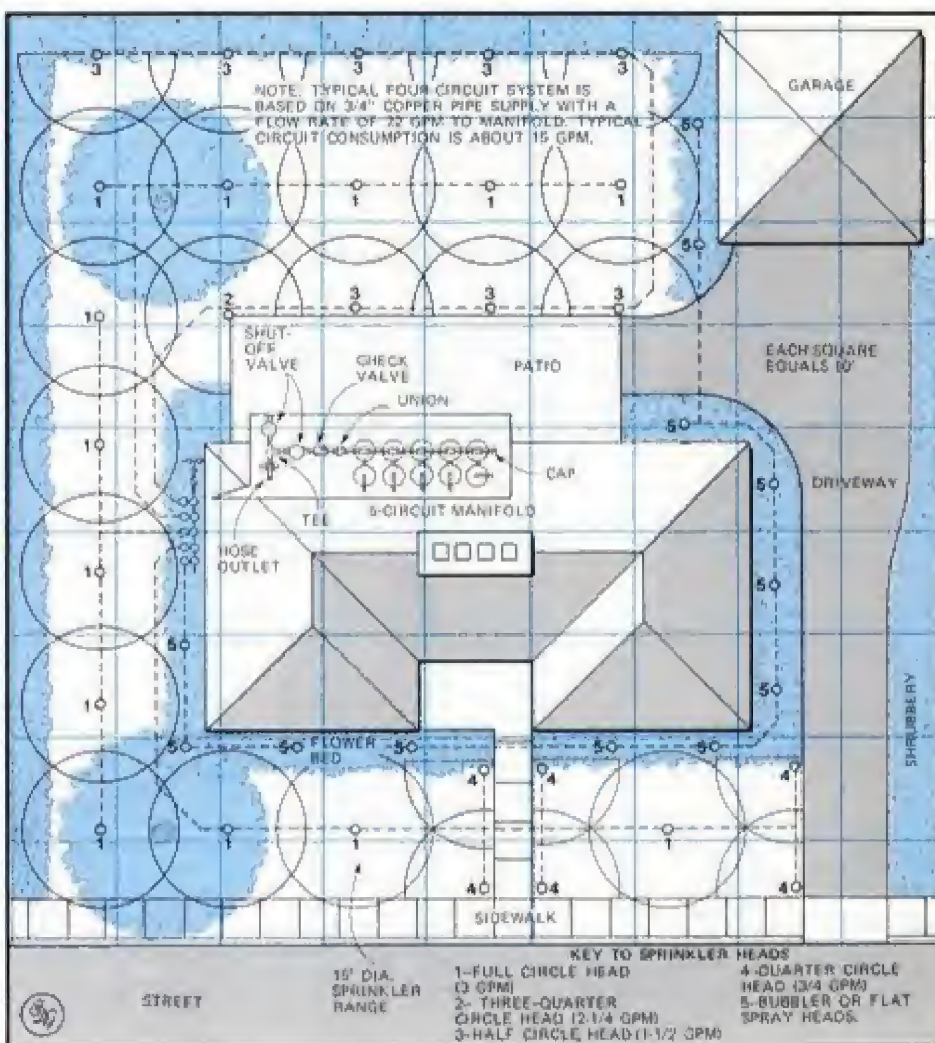
Locate the sprinkler control-valve manifold on the plan. Manually operated valves should be placed in a convenient location, but electrically controlled units can go almost anywhere. Lay out piping from the control valve to the heads. Try not to go under driveways and sidewalks.

Finally, include a shutoff valve so you can service your system easily, and a check valve to prevent contaminated water from syphoning into your water supply.

Connect your control-valve manifold to the water supply, close the valves and check for leaks. Then open valves and flush out any dirt. Use 3/4-in. polyvinyl chloride (PVC) pipe (or 1-in. pipe where pressure or volume is low) to make the runs to the sprinkler-head locations.

Work on one circuit at a time, starting at the control valve and working toward sprinkler heads. Assemble the system above ground. Dig trenches after you check out the circuit. Install automatic drain valves at system low points if you live in an area that is subject to freezing.

After completing the piping, but before you install the sprinkler heads, flush any foreign material from the system. Install sprinkler heads, check the system's coverage and bury it, starting at heads nearest the manifold. Provide a small gravel sump under each automatic drain. Be sure that sprinkler heads are at ground level before you tamp the sod back into place.—James McMahon







The cart is designed to tote young children or groceries at slow pace. See recommended safety improvements on page 264.



Flexible joint is made with tire-wall rubber. An extra safety cable from the bike seat post to part C in plans can be added.

## Bicycle cart

**F**amily cycling trips can be a lot of fun, but what do you do when your child outgrows tot-sized carriers and is still too young to keep up on his own bicycle?

The answer is a two-wheeled bike cart designed for toting kids 3 to 7 years of age. Commercial units are available, but cost between \$140 and \$200. The one shown here can be built for less than \$75.

To keep the construction cost low, polyvinyl chloride (PVC) plastic pipe was used to construct the cart frame. PVC is tough, lightweight,

flexible, requires no finishing and is very easy to work with.

The only tools required to build the frame are a hacksaw, a drill and small cans of PVC primer (cleaner) and cement.

To construct the frame, cut all of the pipe to the lengths specified in the materials list. Dry-assemble the unit to check all parts for fit before using cement to make the final assembly. Attach the canvas sling seat, hitch and wheels as shown in the plans.

This cart is designed to support almost all of the payload on its own two wheels. The tongue weight is

(Please turn to page 264)

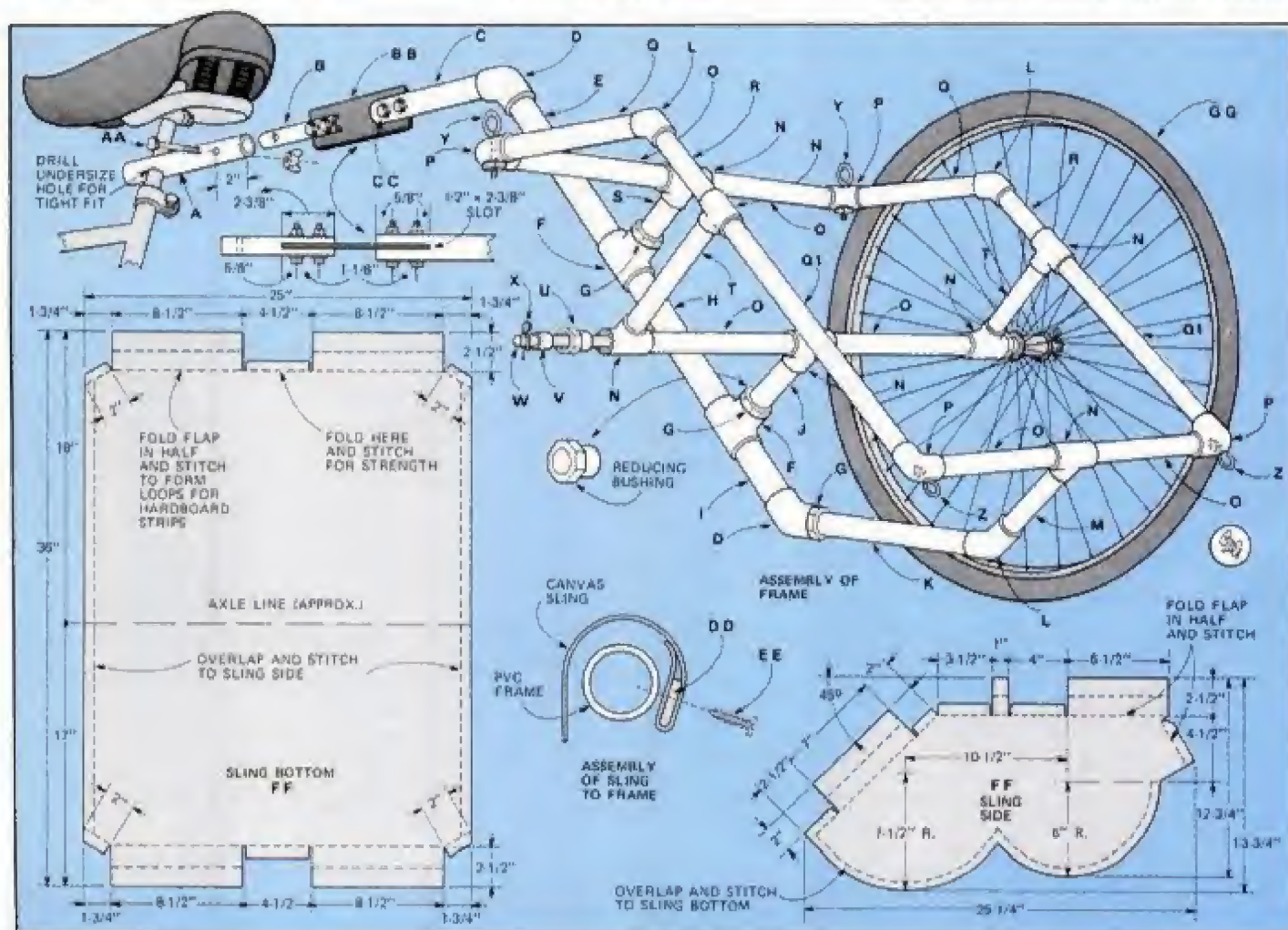
### MATERIALS LIST—BICYCLE CART

Key	No.	Size and description
A	1	1½"-dia. x 8" PVC
B	1	1"-dia. x 6½" PVC
C	1	1½"-dia. x 13" PVC
D	1	1½" x 45° PVC elbow
E	1	1½"-dia. x 15" PVC
F	1	1½" x 1½" PVC tee
G	3	1 x 1½" PVC reducing bushing
H	1	1½"-dia. x 10½" PVC pipe
I	1	1½"-dia. x 3½" PVC pipe
J	1	1"-dia. x 3½" PVC pipe
K	1	1"-dia. x 7½" PVC pipe
L	3	1" x 45° PVC elbow
M	1	1"-dia. x 5" PVC pipe
N	7	1 x 1" PVC tee
O	6	1"-dia. x 11½" PVC pipe
P	4	1" x 90° PVC elbow
Q	2	1"-dia. x 10½" PVC pipe
Q1	2	1"-dia. x 9½" PVC pipe
R	2	1"-dia. x 3½" PVC pipe

Key	No.	Size and description
S	1	1"-dia. x 2½" PVC pipe
T	2	1"-dia. x 5½" PVC pipe
U	2	1" x ½" PVC reducing bushing
V	2	¾" i.d. nylon bushing to fit U"
W	1	¾"-dia. x 36½" aluminum rod*
X	2	cotter pin*
Y	2	eyebolt to suit seat belt
Z	2	eyebolt to hang warning sign
AA	1	½"-dia. x 2½" bolt with wing nut
BB	1	½ x 2 x 6½" tire-wall rubber or belting
CC	4	¾"-dia. x 2" bolt, washer and nut
DD	1	½ x ½" masonite (stiffener strips)
EE	1	½" sheet-metal screws
FF	1	26 x 70" canvas (sling seat)
GG	2	1½ x 26"-dia. wheels with ½" i.d. axle hubs*

Misc.: PVC primer, PVC cement.

\*Available in kit for \$45 postpaid (ties not included). J.H.B. Kits, 10405 Wallace St., Kansas City, Mo. 64134. †As required.





## Super swing set

Using an A-frame for strength, this swing set is very stable and can be built for about \$300. If you can find some materials at the junkyard it will be less. The sheet metal for the sliding board, for instance, was taken from a discarded metal-clad door. Galvanized pipe for

the fireman's pole was purchased for \$2.10 from a scrap-iron dealer.

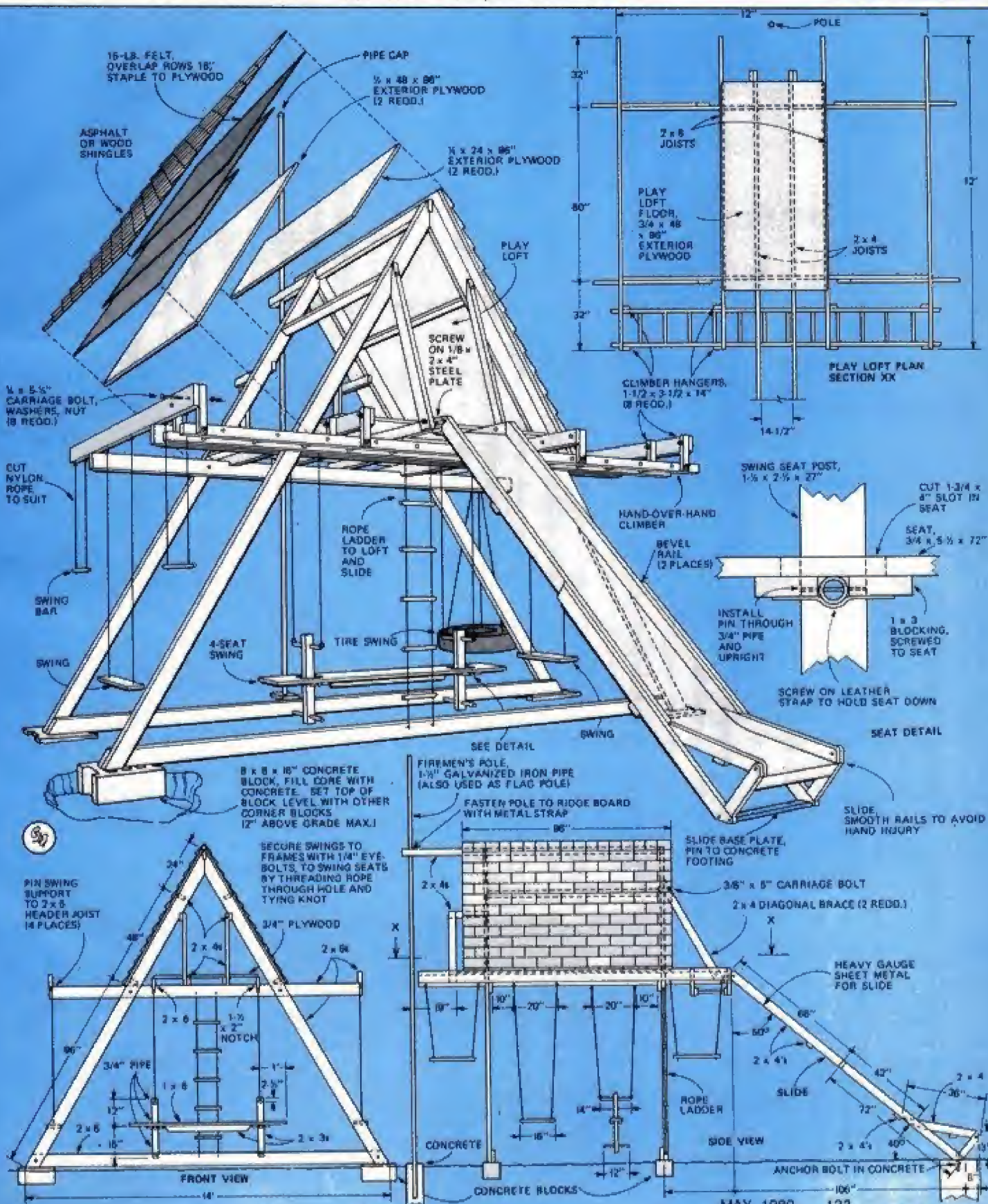
Choose a 16x18-ft. site for the swing set. It should be fairly level and clear of shrubs and other obstacles. In addition, the sliding board will extend about 12 ft. from one side. Level four block footings before getting started on the A-frame.

To construct the frame, assemble the two A-shaped sides on the

ground. Use temporary gussets at the vertex and bolts at other intersections.

Raise, position and plumb each preassembled side with the aid of a helper. Use 1x2 furring as temporary braces until you can nail on the floor joists, ridge board and plywood floor. Temporary braces extending from the front (pole side) and rear

(Please turn to page 264)





# Shape up your pool for



Whip your pool into shape with a thorough spring tune-up, then follow a regular maintenance program for a trouble-free summer.

**W**ith warm weather on its way, the time is right to tune up your swimming pool so you can enjoy it during those hot summer days. To help you get started, we suggest steps you can take for properly opening your pool.

In addition, the following pages contain innovative pool accessories to increase your leisure hours and enhance entertainment at poolside. On page 137, you'll find the latest in work-saving, energy-saving pool equipment.

The basic strategy is to get your pool to the point where you can follow a simple, regular maintenance schedule. There are six steps involved in opening your pool, according to experts at the Sun Swimming Pool Products Div. of FMC Corp. The

## 6 steps to get your pool ready for summer

steps take two to four days to complete, depending on such considerations as how well you protected the pool during the winter and how large it is.

Make sure that you perform each step successfully before continuing to the next.

### 1. Fill the pool

If you've properly winterized your pool, cleanup is a minimal task. The recommended level for filling most pools is to the middle of the skim-

mer, the built-in device that traps surface debris.

Pool water evaporates and is dragged and splashed out by swimmers. You'll have to add water periodically to maintain proper level.

### 2. Check equipment

Check the pump, filter and circulating system. Refer to the owner's manual for reinstalling parts removed for winter storage. Make sure mechanical components are clean and in proper working order.

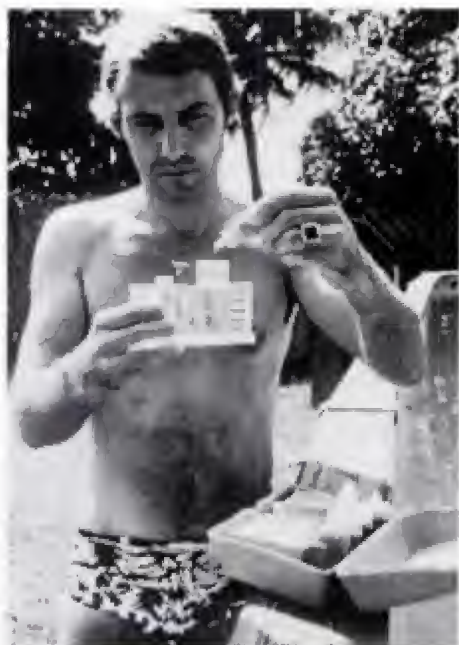


# a carefree summer

To reinstall the pump/motor, first turn off the power at the control panel. Replace the gasket between the pump's tank and seal plate if it is damaged. Reinstall the drain plugs. Check the pump shaft for free movement. With power on, prime the pump following instructions in the owner's manual.

## 3. Adjust pH level

The pH level is a measure of the acidity or alkalinity of water. Unless



Unless pH is properly adjusted, chlorine can't keep water clean. The ideal pH level ranges from 7.2 to 7.8. Levels too high or too low can give swimmers eye burn.

your pool is within a certain pH range indicated by a test kit, chlorine disinfectant won't kill the bacteria that it's supposed to.

The level at which chlorine optimally sanitizes ranges from 7.2 to 7.8. To get an accurate measure, follow the manufacturer's directions in your pool kit.

If pH is too *low*, chlorine dissipates rapidly, pipes and fittings can become corroded, plaster can become etched and swimmers can get an irritating eye burn.

If pH is too *high*, scale forms, pool water turns cloudy and swimmers get eye burn just as they do when pH is too low.

If the pH level is too low, add a pH plus chemical; if the level is too high, add a pH minus chemical.

**Note on water testing:** To properly care for your pool, you will need a

complete kit or individual kits to measure pH level, total alkalinity, chlorine level and water stability. Each year change test chemicals (reagents) that are in your kit.

## 4. Adjust total alkalinity

After you've adjusted the pH level, adjusting total alkalinity helps keep the pH in the proper range. The three main alkaline chemicals—carbonate, bicarbonate and hydroxide—dissolved in the water in proper proportion act as a buffer preventing pH change.

Use a kit to test for total alkalinity. Test it weekly and maintain it between 80 and 150 parts per million (ppm, the standard measure of concentration in swimming pools). Your pool-supply dealer can also tell you if an alkalinity problem exists in your area and can provide formulations needed to correct it.

## 5. Superchlorinate the water

Superchlorinating means applying 5 to 10 times the regular daily dose of chlorine to water. The two primary reasons for adding chlorine are: 1) to disinfect—kill water-borne organisms and algae; 2) to oxidate—burn out undesirable solids, colors and odors. While all pools must be superchlorinated from time to time, it is definitely needed when opening your pool for the season.

Before you superchlorinate, determine the capacity of your pool in gallons; then determine the needed dosage of superchlorinator following directions on the package. Wait until the residual chlorine is at the recommended level of 1.0 to 1.5 ppm according to the test kit before continuing to the next step. You might want to superchlorinate at night and then test the water the following morning.

There are several types of chlorinating products on the market. Among them are liquid chlorine and calcium hypochlorite, which tend to lose effectiveness after a few hours due to the action of sunlight. On the other hand, chlorine concentrates in tablets or granular form contain a built-in stabilizer that resists chlorine decay induced by sunlight.

## 6. Stabilize the water

The final step in getting your pool ready is to stabilize or condition the water. This process minimizes the loss of chlorine due to ultraviolet

sunrays. It also makes sure that the chlorine disinfectant will keep working around the clock.

To complete this step, you'll need a test kit and a conditioner chemical. Results from the kit will tell you how much conditioner you should apply. Each time you refill the pool, you should also stabilize the water.

## Computerized analysis

To make pool maintenance somewhat easier, computer systems that



Chlorine concentrate in granular form sprinkled into the pool (or in tablets used in floating or in-line feeders) simplifies superchlorinating task and daily pool care.

can identify potential problems in the pool water are available. The water can be tested before the pool is filled, after it is filled or during the season.

Basically, a water sample is run through tests to analyze and balance it. The results, along with information about the specific pool, are programmed into a computer that completes a data sheet telling *what* chemicals are needed and in *what order* and *quantity* to apply them to maintain your pool water safely.

The service is available at pool dealers. However, it doesn't take the place of careful monitoring by pool owners. Before you purchase a large amount of chemicals based on the results of such a test, it pays to satisfy yourself that the chemicals are needed.

PM



# Shape up your pool

## 7 new products

The hot, bubbly water jets of this hot tub are just the thing to soothe tired muscles. Tub of redwood, cedar or mahogany staves is 4 ft. deep and ranges from 4 to 7 ft. in diameter. Prices from \$1800 to just under \$3250 include the tub, bench, pump, heater and four-jet whirlpooler. It's available from California Cooperage, Box E, San Luis Obispo, Calif. 93406.



Soak up the sun while drifting luxuriously on this vinyl-wrapped, closed-foam lounge. It's made the same way as a ship's life-saving gear. You can use it also on a deck, pool-side paving or beneath a sleeping bag. Called Aqua Sun Lounger, it's priced under \$160 from Poolmaster, 160 Jefferson Dr., Menlo Park, Calif. 94025.



Stretch the swim season with an air-filled vinyl dome. Low-pressure blower (right of dome) operates only when there is a pressure drop within (as when someone opens zipped door). A 20x40-ft. dome fits an average (16x32-ft.) pool. With blower, dome runs about \$1315 from SAC, 17 Cotters Lane, East Brunswick, N.J. 08816.

Dress for a dip by poolside. His-and-hers cabana of ribbed aluminum is easily assembled of prebuilt panels. It's 6 ft. 2 in. x 4 ft. 1 in. and adjusts to a 6-ft. 5½-in. height. Cabana also holds swim equipment, since center partition comes out. It costs \$425 from Cabanarama, Box 945, Northwest Branch, Miami, Fla. 33147.



Floating fountain is pleasing addition to an existing or new pool. Out of the carton, the fountain is operational in minutes. Just attach the hose to pump, pool return line or garden hose. In blue or white, float has 20-in. diameter. It's priced at \$80 from Fountains For Pools, 19151-J Pathenia St., Northridge, Calif. 91324.



It looks like a natural stone spa and water cascade, but it's a fiberglass unit that drops into a shallow excavation by your pool. The 8x16 ft. model shown (\$5500) includes a spa, waterfall, pump, filter and heater. An 8x9-ft. model (\$4600) is also made by Sun Country Distributing, 2224 West Desert Cove, Phoenix, Ariz. 85029.



Picnic under a redwood gazebo. The prefabricated lattice panels need no foundation and bolt together in less than a day. Assemble them with a hammer, screwdriver, wrench and measuring tape. They come in widths that range from 7¼ to 12½ ft.; prices are \$895 up to \$1495. From California Lattice Co., 616 North Eckhoff, Orange, Calif. 92668.



# 7 worksavers



Computerized pool/spa and solar heater system automatically controls pool operations. System (\$1106) has in-door control (inset); power center; solar, intake and return valve operators; two temperature sensors. Remote control shown at spa (\$108) is optional. Compool Corp., 333 Fairchild Dr., Mountain View, Calif. 94043.



Keep-N-Heat chemical stays on the pool water surface and inhibits evaporation and heat loss. It's odorless, tasteless, invisible and passes through the filter, according to its maker. A 32-oz. bottle costs \$6 from Great Lakes Biochemical Co. Inc., 6120 West Douglas Ave., Milwaukee, Wis. 53218.



You can drain your pool with the Water Wizard pump. Attach a 1-in.-dia. pipe or garden hose, set it in the water and plug it into a grounded 120-volt a.c. outlet. The pump removes water to within 1/8 in. of the floor. It's \$60, including an 8-ft. cord, from Little Giant Pump Co., 3810 North Tulsa St., Oklahoma City, Okla. 73112.



Photozone process water purifier sanitizes pool water by oxydizing pollutants and killing bacteria, thereby cutting chemical need by more than 50 percent, says its maker. Several pool models from \$795 are made (as well as a smaller spa model) by Ionization International Inc., 1819 West Grand Ave., Chicago, Ill. 60622.



This solar collector for pools comes in a custom do-it-yourself kit. Panels have upper and lower headers of 2-in.-dia. polypropylene, joined by polybutylene tubing cut to length. Kits with 600 sq. ft. of collector surface are offered for under \$2000 by Sunco Products, 243 South Indian Ave., Palm Springs, Calif. 92262.



MANIFOLD  
TUBING



The Poolsaver is a motorized vinyl cover that slides into place on rollers in less than a minute, according to its maker. The cover seals tightly to save water and energy and act as a safety device. Prices for the Poolsaver, including installation, start at \$2500 from Cover-Pools Inc., 117 West Fireclay Ave., Murray, Utah 84107.

V-BAND CLAMP AND KNOB  
ALLOW EASY  
REMOVAL OF COVER



2-SPEED SWITCH  
ALLOWS PUMP SPEED  
TO BE CONTROLLED

The EnergiSaver MarDur pump, designed for swimming pools, works at two speeds: high, during heavy pool loads and low, during light-load periods and at night. It operates with no loss of clarity or chemical balance to the water, the company claims. Models range from 3/4 to 2 hp (1 1/2 hp shown) and cost \$300 to \$500 from Marlow Pumps, Midland Park, N.J. 07432.



# WORKSHOP MINICOURSE

## GETTING MORE FROM YOUR DRILL PRESS



No matter which bit you use in the drill press, if you don't use a backup block, the hole will splinter on the back side. Here, a brad-point bit will pass through the workpiece and into the table's center hole.



Hardwood makes the best backup board. Plywood is too soft and doesn't provide adequate work support. It's also important to move the backup block after each boring to insure it being in solid contact with work.



For drilling precision holes without splintering, set depth stop so drill stops boring just after breaking through the back side (arrow). Bore the hole and flop the workpiece to complete hole from second side.



A back view of a board showing the results of three different methods of boring: 1, without backup block; 2, with an inadequate backup board; 3, a hole made using the bit from both sides, as shown at the left.



Dowel plugs are a lot cheaper if you make them yourself. When they are cut from project scrap material, they match perfectly. Start by boring a row of plugs to maximum depth on either board edge or face.



With a scroll saw or bandsaw, nip off the plugs. If you make cutoff on the table saw, apply masking tape over insert's hole to keep the plugs from dropping through and getting lost. And, use a slow feed rate.

**T**hough there are many accessories that let you perform varied tasks on the drill press, you'll find that when you turn to this tool, more often than not it is to drill a hole.

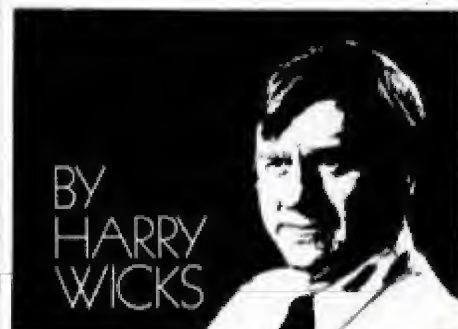
When boring in wood, it makes a lot of sense to use a backup board to minimize splintering where the bit breaks through on the back side. But don't think that this technique automatically assures a perfect hole on both sides. It doesn't, as you can see in the photo of the sample block of wood at left. Even a fine, accurate bit, such as a brad or spur point, will cause splintering if the drill press isn't used correctly.

The most common mistake, probably, is choosing the wrong speed. A table recommending the speed to use with various materials of varying thicknesses is included in your owner's manual. Since it takes only seconds to change belt position, and thus spindle speed, use this chart when you are working with a new or unusual material. However, recommended speeds can vary considerably. For example, in  $\frac{3}{4}$ -in. stock (the material that you are likely to work with most of the time), you would use about 1250 rpm to bore a hole in softwood. To bore the same hole in a piece of hardwood (such as oak or maple) you should slow the press down to 700 rpm.

The best way to produce a clean hole on both sides is by boring from both sides. With a brad-point bit, you set the depth stop so boring stops when the bit point penetrates the bottom side. Flip the workpiece and then finish the hole from the second side.

To produce a series of clean holes, first bore straight through with a small-diameter bit. Then, insert the correct diameter bit and set depth so the bit bores slightly more than half-way through. Bore the holes from both sides.

PM





# Popular Mechanics CAR CARE GUIDE 1980

WHETHER YOUR CAR IS FACTORY FRESH OR BEGINNING TO SHOW ITS AGE, YOU CAN'T AFFORD TO NEGLECT REGULAR CARE. THE 50 STEP-BY-STEP PROCEDURES IN THIS SPECIAL SECTION WILL KEEP IT RUNNING STRONG FOR YEARS.



1980 Aston Martin Volante

**Poor fuel economy, hard starting, overheating, spongy brakes, lack of engine power**... do any of these problems sound familiar? If you've experienced some or all of these headaches you know how frustrating and expensive they can be. How about **excessive tire wear**, a **dead battery**, a **balky clutch** or a **stumbling transmission**? You can cure all these ailments and prevent them from happening again with **PM's** comprehensive maintenance guide. Good car care is for everybody. This year don't leave it all up to your mechanic.





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# CAR CARE GUIDE

## 1980

Popular Mechanics



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Prepared by the editors of Popular Mechanics with technical art by Dale Gustafson, Fred Wolff, Ed Lipinski, Hank Iken, Fred Neinst and Gerhard Richter. Photography by Jerry Abramowitz and Norman Blake. Design of the Car Care Guide by Don Mannes.

## When Should YOU Change Engine Oil?

How you drive determines how far and how often you should change your crankcase oil. It is nearly impossible to drive a car properly so that yearly changes of oil would be safe for your engine.

Traffic jams, winter warm-ups, short runs, taking kids to school, and those short trips to the store all tend to shorten the life of your oil.

On top of that, today's engines are smaller, work harder and run hotter. All of these things help foul up engine oil, create varnish, gum and sludge as they use up the additives in the motor oil.

A quart of Rislone with each oil change and new filter will help get rid of power robbing deposits, and clean engines run better, longer and more economically than dirty ones.

Look for the big QUART red, yellow and black Rislone can. For 40 years, motorists have been telling us that Rislone really works!



Send a stamped self-addressed envelope for your Free Copy of our 40 page LUBE TIPS booklet. It will answer some of your questions about engine lubrication.

### THE SHALER CO.

21 East Jefferson St.  
WAUPUN, WISCONSIN 53983

In Canada: Warren Packaging Co.,



**CAR CARE GUIDE**  
1980

# A CARED-FOR CAR

These well-maintained beauties not only retained their



Thanks to good car care, the 1962 Chevrolet Chevelle (left), 1970 Oldsmobile 442 (lower left) and the 1963 Rambler Classic (right) are running as strong as the day they left the showroom. Rick Cognat, owner of the Rambler, inherited the car from his father when it had 100,000 miles on the clock. At nearly double that mileage it still provides reliable, daily transportation.



PHOTOGRAPH BY NORMAN BLOOM



# IS MONEY IN THE BANK!

original price, but are appreciating in value.

The 1959 Corvette (left) has tripled in value since owner Burt Beebe purchased it. The 1966 Chevelle (right) has not done as well. It has only doubled in value. Each of these cars has been immaculately maintained.



**P**lanned obsolescence? The owners of these cars never heard the words.

Take, for example, the Rambler Classic. It is owned by the Cognet brothers, Rick and Robin, of Staten Island, N.Y. Originally purchased by their father, it became theirs a few years ago when the odometer read a shade over 100,000 miles. After an engine rebuild—the only major work ever performed on the car—they've nearly matched that mileage. The car is used every day as a workhorse commuter vehicle and, strictly speaking, the only pampering it gets is the regular maintenance they perform. The

Cognets believe that maintenance just plain makes sense if you want to keep your car looking like the kind of money you spent for it. At the rate they're going, the Rambler will be around for a long time.

The same goes for the 1959 Corvette, our cover car, owned by Burt Beebe. It isn't a museum car or a "show-only" car. He drives it all the time in what is probably the toughest auto environment in the country, the streets of New York City. Is there a secret to his car's longevity? Certainly not.

Beebe and the rest of the owners of the cars on these pages learned a long time ago that the "secret" is regular maintenance.

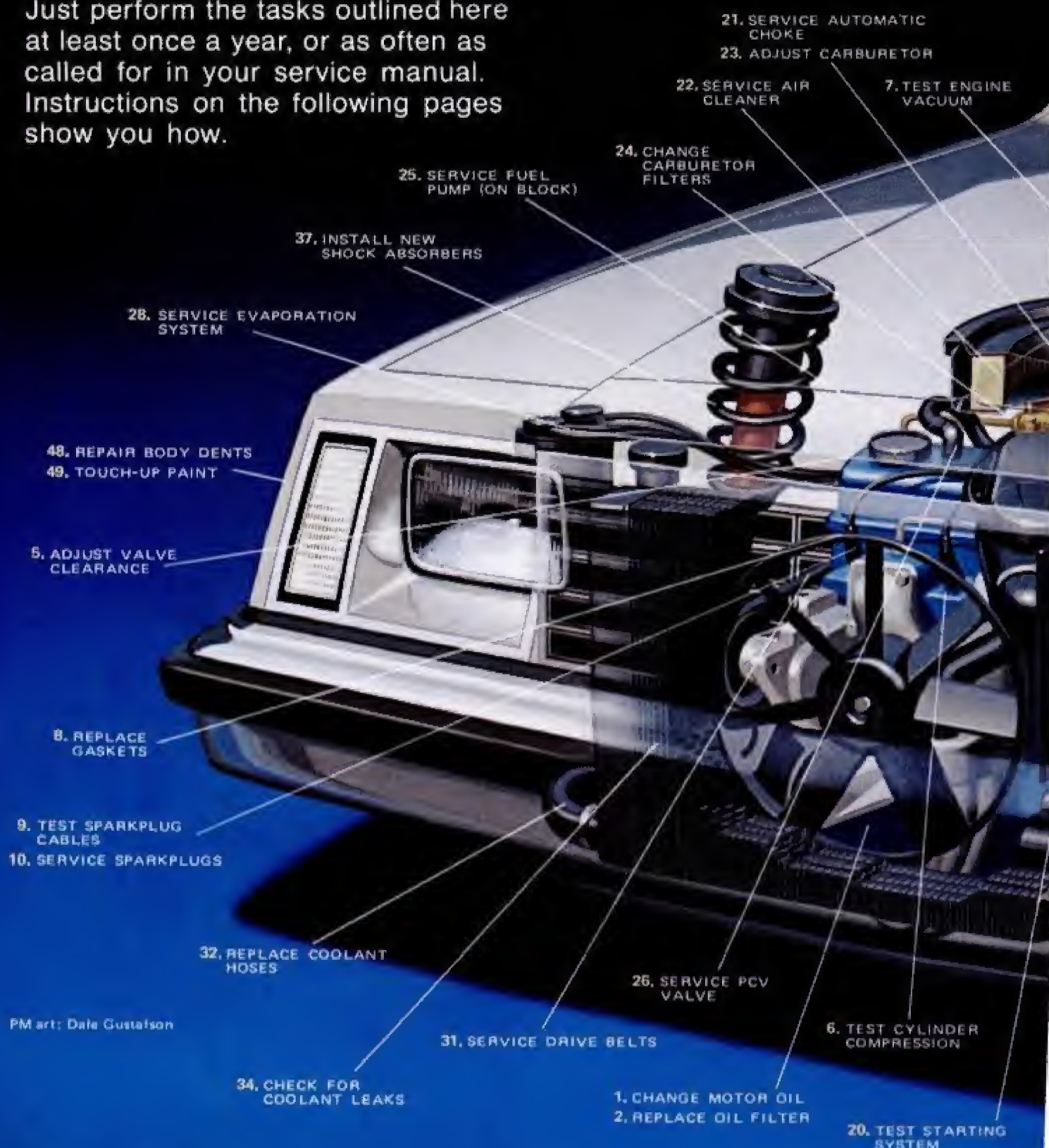


Awesome Cobra 427 worth \$25,000 sold for under \$5000 new in 1967. Most cars won't appreciate that much, but regular care will make any car's original tab pay off.



# Car care by the numbers

These fifty ways to love your car will keep it running like new long after the warranty runs out. Just perform the tasks outlined here at least once a year, or as often as called for in your service manual. Instructions on the following pages show you how.



PM art: Dale Gustafson



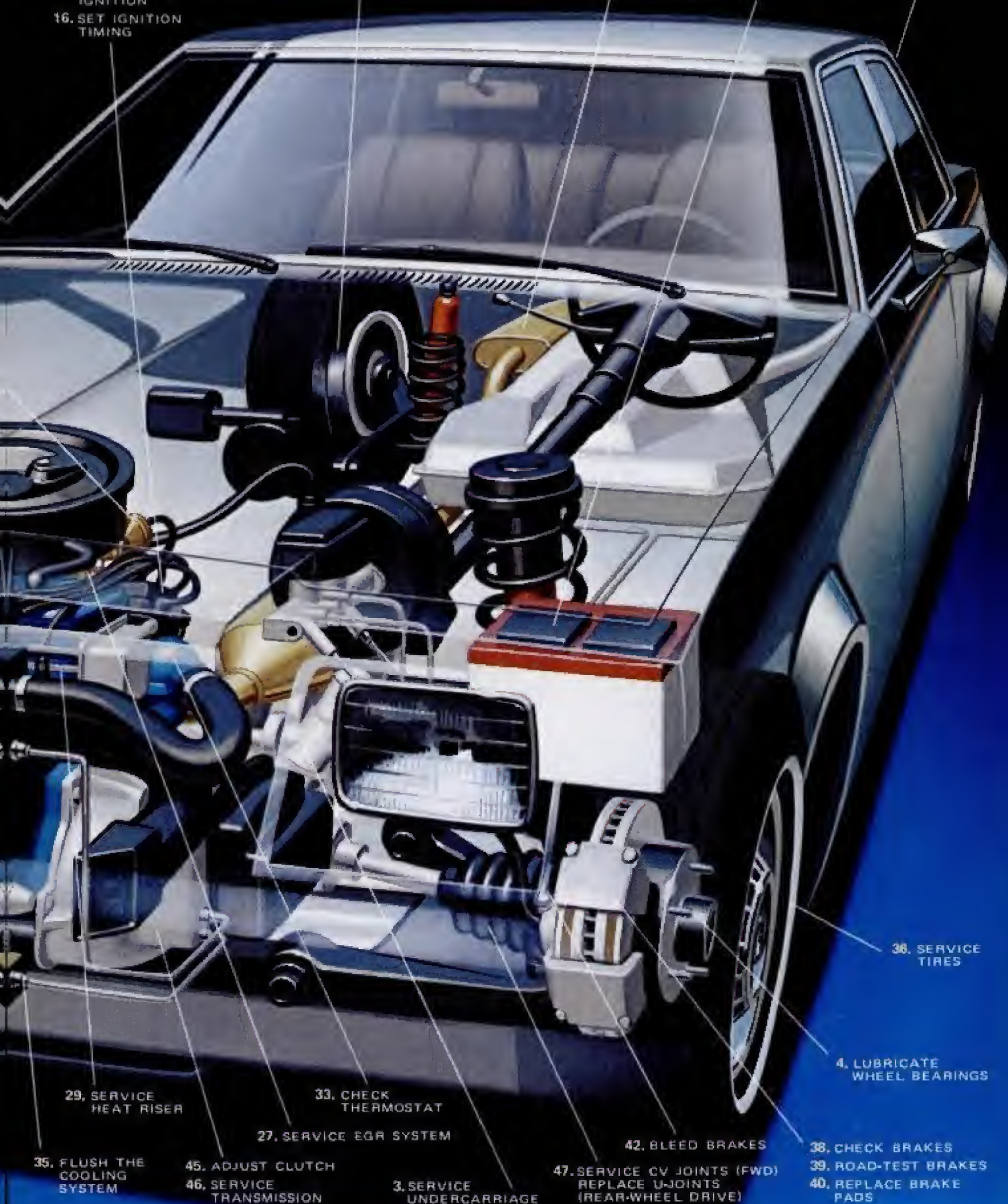
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# CAR CARE MONTH

Car Care products to help keep your car in top-notch condition can be found at the Automotive Parts & Accessories Association Member Retailers listed on these pages. Many of these outlets are offering money-saving specials during "May is Car Care Month." Many of the

quality products featured in the CAR CARE GUIDE are included in these sale promotions.

Watch your local newspaper for the special Car Care sections that contain car care information and announcements from your neighborhood Car Care Month Retailers.

<b>AA AUTO PARTS</b>	WA	<b>Avellino's</b> Tire & Auto Service Centers	PA, NJ		IL		MN
 AUTO SHACK	AZ	<b>BALE</b> TIRE CENTERS	KY	<b>FINLEYVILLE</b> AUTO PARTS INC.	PA		AL, AR, KY, TN
	AK, AL, AR, AZ, CA, CO, CT, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MA, MD, MI, MN, MO, MS, MT, NC, NE, NJ, NM, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, WA, WI, WV, WY		MN, WI		IN, OH, KY		WA
	MI		IL, IN		IL, NY, OH, PA		CA
	NC, SC, TN, VA	<b>BOWDEN'S AUTO PARTS INC.</b>	WA		PA		TX
	NJ, NY, CT, FL	<b>BUCHANAN</b>	AL		AK, WA		ALL STATES EXCEPT AK
	NJ				PA, WV		TX
	CA		PA		HI		IL
		<b>CENTRAL HARDWARE</b>	IL, IN, MO, TN		MI		IL
	MO	<b>CHAMP AUTO PARTS</b>	NH		CA, NV		MA
	OK		IA, MN, MT, ND, SD, NE		IN		IL
	NJ, NY	<b>IN MATHE: CONSUMER AUTO PARTS</b>	ME		IN	<b>MARINO'S HOME &amp; AUTO INC.</b>	PA
	PA	<b>NEW HAMPSHIRE: CHAMP AUTO PARTS</b>		<b>HERBIES AUTO PARTS, INC.</b>	DE		MA, NH
			MA		MO, VA		IA, NE
			IN, OH		IN, MI, OH		VA
			MN				
		<b>DART @ DRUG</b>	MD, DC, VA				
		<b>DART @ HOME</b>	MD, VA				



**F**or the eighth consecutive year, POPULAR MECHANICS and the APAA are joining forces as co-sponsors of "May is Car Care Month." This is a positive indication of the success of the program and a measure of how meaningful it has become to automobile owners and the manufacturers and retailers of car care products.









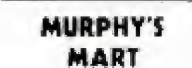












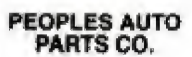






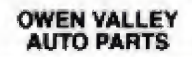
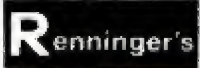

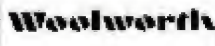









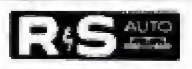


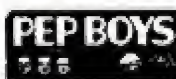



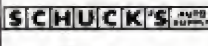




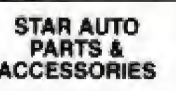


With the increasing emphasis being placed on the efficiency and economy of automobile operation, this may be one of the most important Car Care Months yet! The valuable

car care information circulated during May will help keep your car in top running condition. And by leading you to the special sales offered during Car Care Month, will save you money. Not only will you "Drive a Happy Car" but you will be a happier, well-fixed driver.

**Popular Mechanics**

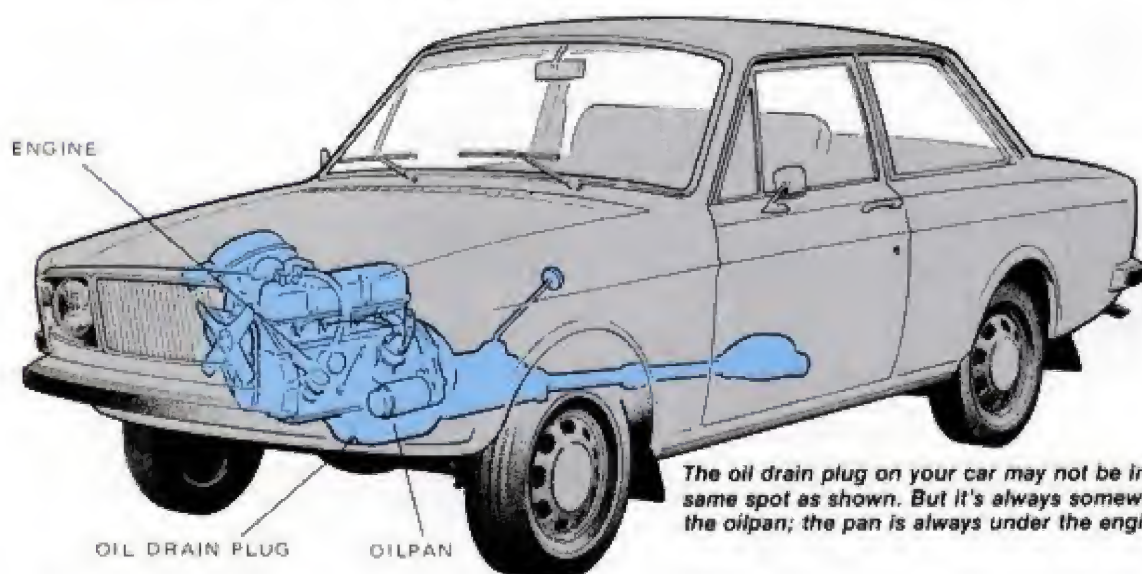
**APAA**

## RETAIL MEMBERS

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	AL, FL		OH		VA		ALL STATES EXCEPT SD
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	IN		PA		ID, WA		AL, ID, ME, MN, NC, VT, FL, IL, MI, MT, TX, WY
	HI		MI		AK, WA		NV
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	CA, AZ, DE, NJ, PA, VA, DC		FL		ALL STATES		AL, CT, FL, GA, IL, IN, IA, KY, ME, MD, MA, MI, MN, MS, MO, NH, NJ, NY, NC, OH, PA, RI, TN, VT, VA, WI
			OR, WA		CT, FL, HI, IL, IN, IA, ME, MD, MA, MI, MN, MS, NH, NY, ND, NC, OH, PA, RI, TX, UT, VT, WI		MN
			NJ				WI
			IL				
			ID, OR				
			NY				



# 1. Changing motor oil



The oil drain plug on your car may not be in the same spot as shown. But it's always somewhere in the oilpan; the pan is always under the engine.

**O**il is the lifeblood of your engine. By changing it regularly you can extend engine life and avoid major repair. Fortunately, it is one of the easiest maintenance tasks.

**1. Warm up the engine** so the full load of dirty oil will drain from the pan. Heat thins oil, allowing a ready flow. Conversely, cold oil is thick. Some may remain in the engine.

**2. Lift the front of the car** or leave all four wheels on the ground. If you lift the vehicle, support its weight on safety stands. Do not work beneath a car which is supported only by a jack. Accidents happen. Engage the parking brake; place an automatic transmission in PARK and a manual transmission in gear. If you raise the front of the car, place chocks behind the rear tires to prevent roll-back.

**3. Place a drain pan** (six-quart capacity) under the drain plug and loosen the plug with an adjustable, box, open-end or socket wrench. Whichever one you use, make sure it fits the plug snugly to avoid damaging the plug.

**4. Remove the loosened plug by hand.** To avoid burning your fingers, be ready to draw your hand back quickly as oil begins flowing. Allow oil to drain completely. This takes about three minutes.

**5. Wipe the drain plug clean** and check to see if it has a gasket. If the plug has a gasket, the gasket must be kept in use to avoid an oil leak. However, to be effective, the gasket must be in good condition. If it isn't, replace it.

**6. Thread the drain plug into the oilpan** (don't cross threads) and tighten by hand. Then, using a wrench, tighten the plug snugly. Do not over-tighten. You may distort the oilpan.

**7. Add fresh oil** of the correct API classification and SAE viscosity through the oil

filler on the engine, until the dipstick shows the oil level at FULL.

**8. Check around the oilpan drain plug for leaks.** Tighten the plug if there's a leak.

### Selecting the right oil

The American Petroleum Institute (API) classification system uses the symbols SE, SD and SC to designate oil suitable for automobile engine use. Symbols signify the ability of oil to protect engines of designated model years against wear, rust, corrosion, sludge and other detrimental factors caused by normal use.

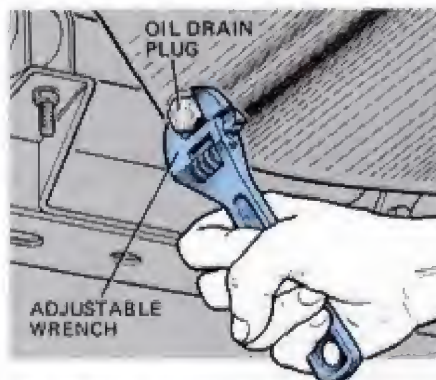
SE engine oil provides maximum protection between manufacturer-recommended oil-change periods for 1980 and all prior models. SD engine oil is suggested for 1970 and all older models. SC engine oil is the suggested choice for 1967 cars and all earlier models.

See that the can of oil you select bears the symbol of the type oil you decide to use. The symbol may be used by itself (SD, for example) or in conjunction with others, such as SE-SD-SC. This means the oil is intended for SE use, but, obviously, also fulfills the needs of SD and SC use.

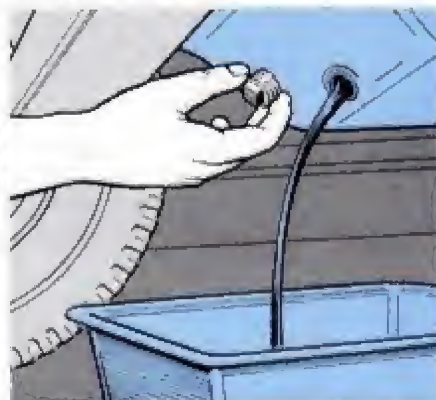
Consult your owner's manual for the oil viscosity to use. This is based on anticipated ambient temperature of an area.

Viscosity, or weight, is a numerical rating system established by the Society of Automotive Engineers (SAE) that designates the resistance of oil to flow. Thick, slow-flowing oils have high numbers; thin, free-flowing oils have low numbers. The W following a number means that viscosity was determined at 0° F. and the oil is intended for use in cold weather. If there is no W, viscosity was determined at 210° F., and the oil is intended for use in warm weather.

Oils with two numbers, such as SAE 20W-40, have the ability to change viscosity as temperature changes, being light enough to allow easy engine-starting in cold weather, yet heavy enough to provide proper engine protection at high temperatures. **PM**



The wrench should fit exactly to avoid damage, making plug removal difficult.



Remove the plug and let oil containing contaminating deposits drain completely.





*The freezer. There's a Ford Granada in that block of ice — with Shell Fire & Ice motor oil in its crankcase. After we chopped through the ice, we turned the key. The engine started in four seconds.*



*The oven. Same test car, same Shell Fire & Ice, towing a 30-ton crane in the Mojave Desert 36 hours later. The oil temperature hit 270°F (well above normal). But Shell Fire & Ice protected the engine.*

## From the freezer to the oven in 36 hours: The Shell motor oil that had to earn its name.



Take a new Ford Granada and ask it to crank up fast, frozen in a huge block of ice. Then, after you've thawed it out, ask it to pull a 30-ton crane through several miles of Mojave Desert.

Do that and you aren't just asking the car to perform. You're demanding peak performance from its motor oil.

### **A frozen Ford gets a quick start**

Shell Fire & Ice® 10W-40 is an *all-season* motor oil. And an all-season motor oil should be able to help cold engines start fast.

Enter "the freezer."

First we built a special mold to hold our Ford Granada.

Then we put it in a gigantic freezer at zero degrees and sprayed in gallon after gallon of water. Layer by layer, the water was frozen around the car.

Inside the Ford's crankcase, the oil temperature dropped to well below freezing.

When we removed the walls of the mold, the ice was so solid that it took us an hour with two pickaxes to hack our way into the passenger compartment.

Finally, we turned the key.

Immediately, the engine cranked. In four seconds, it started. We'd gotten our Shell Fire & Ice All Season Motor Oil down to subfreezing, and it *still* helped the engine start fast.

### **"The Oven"**

An all-season oil also has to protect when the going gets hot. And the going that gets an oil the hottest is towing a heavy load.

So after we'd defrosted our test car (a 36-hour task), we hooked it up to the crane we'd used to lift the ice block out of its mold.

The crane weighed in at over 60,000 pounds — the Ford Granada, a mere 3,500 pounds.

We started towing. By the time we'd gone several miles, the oil temperature had hit 270°F. Well above normal.

Did Shell Fire & Ice protect? We tore the Ford's engine down the next day for a closer look. And after carefully examining its critical parts, our technical experts had the proof:

There was not one bit of abnormal engine wear. 36 hours after helping a cold engine start fast, the same Shell Fire & Ice Motor Oil had protected an extra hot engine.

### **Gas-saving formula.**

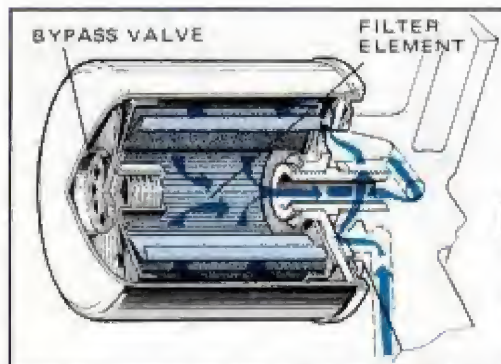
Shell Fire & Ice All Season Motor Oil is formulated to save gasoline. Your mileage will depend upon car and conditions.

So change to Shell Fire & Ice 10W-40 Motor Oil today.

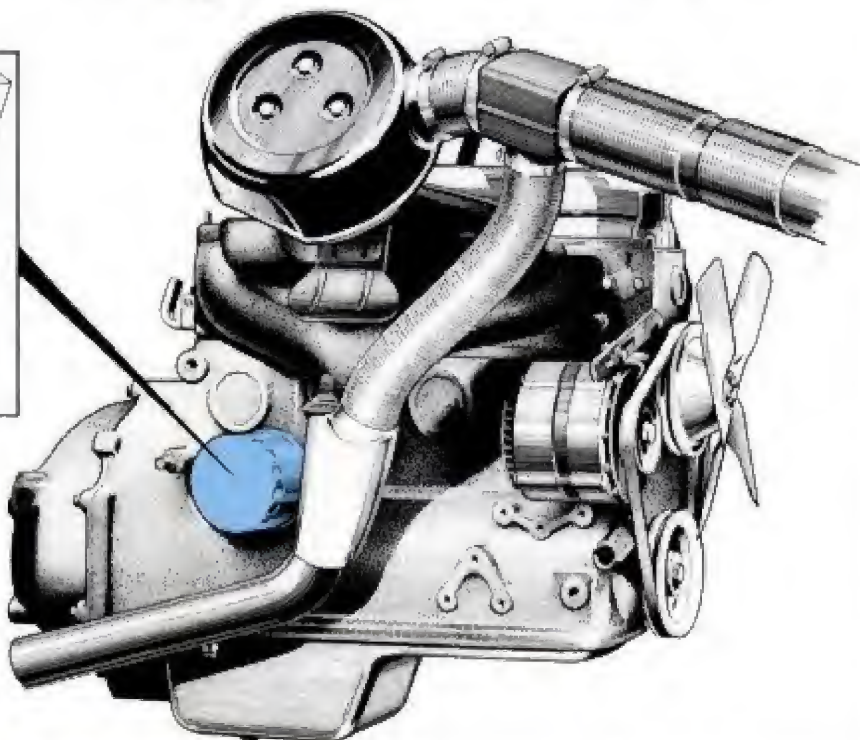




# 2. Replacing an oil filter



Full-flow, oil-filter bypass valves allow oil delivery, even if the filter clogs.

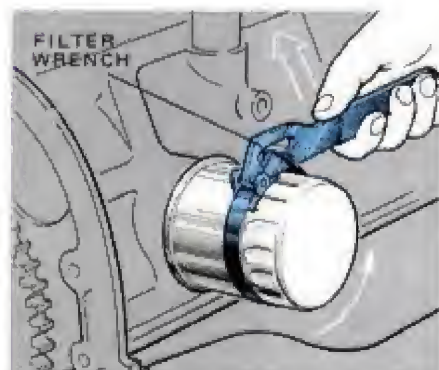


The oil filter on your car is probably a full-flow filter. This means that the oil pump delivers oil through the filter before oil is distributed to the engine.

However, in the event that extremely cold weather causes the filter to clog or the oil to become too thick to flow through the filter, a bypass valve will route oil around the filter element to the engine. This way, your engine will never starve for oil. Oil delivered to the engine through the bypass will, of course, contain abrasives and sludgy elements that will accelerate engine wear.

Filters get clogged with sediment and particles if they are kept in use too long. Therefore, it is important that you replace an oil filter at the time intervals recommended in your owner's manual. In many cases, this schedule calls for installing a new filter in a new car the first time the oil is drained and every second oil change thereafter. If you use the vehicle under severe conditions, such as pulling a trailer, extensive short-trip driving, idling for long periods, or driving in dusty areas, replace the filter each time you change the oil.

### 1. Place a drain pan under the oil



Turn the oil-filter wrench counterclockwise to loosen and remove the filter.

filter before adding fresh oil to the engine (see *Changing Motor Oil*, page 148). This will catch any of the fresh oil that may spill while you work.

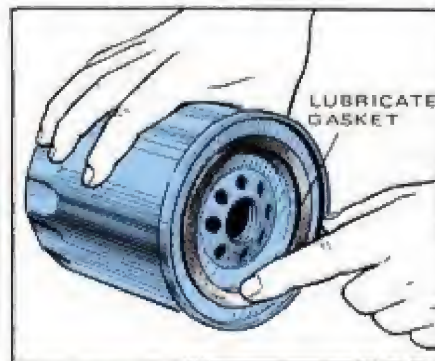
**2. The filter may be reached from inside the engine compartment**, depending on its location on the engine. If it's not accessible, you'll have to get beneath the car. Be careful that you don't grab the filter with your bare hand. Since the engine was warmed up prior to draining the oil, the filter will be hot.

**3. Place an oil-filter wrench around the filter.** If you are just now purchasing a wrench, make sure that it's the right size, because not all wrenches fit all filters. Be ready to tell the salesman the year, make and model of your car and the cubic-inch displacement of the engine. You'll also need this information if you want to purchase the correct filter.

**4. Turn the wrench counterclockwise to remove the filter.** If the filter is frozen to the engine, remove the wrench and drive a chisel through the filter canister, but watch out for hot oil that may splatter. Then hit the chisel with a hammer to loosen the old oil filter.

**5. If old gasket material sticks to the filter seat on the engine** after you have removed and discarded the filter, scrape the seal clean and wipe it with a dry cloth.

**6. Wash your hands**, and then dip a finger into some clean engine oil and lubricate the gasket of the new filter. Also lubricate the filter seal on the engine. Lubrication assures



Apply oil to the gasket of a new filter to secure a tight fit with the engine.

that you will have a secure fit between the two.

**7. Thread the filter by hand onto the engine.** Be careful not to cross or strip threads on the filter. When the gasket touches the filter seat on the engine, hand-turn the filter another half to three-quarter turn to secure it.

In the past, manufacturers have warned not to tighten the filter with a wrench, because the filter may be difficult to remove next time you have to replace it. Some now say to use a wrench to assure a tight, leak-proof seal. Take the moderate approach. Tighten the filter by hand. After you have filled the crankcase with oil, start the engine and check around the filter for leaks. If you find one, tighten the filter with the wrench until it stops.

PM





There's a reason so many sports car enthusiasts who own a truck, own a Toyota SR-5 Sport Truck. It's more than just the presence of a 5-speed transmission, or bucket seats. Call it a feeling, the way everything works together. Because "feel" is what sports cars, and the SR-5, are all about.

You'll know what we mean the moment you start the 2.2 liter engine.

It pulls hard, yet the 5-speed shifts into gear with a light, precise feel many genuine sports cars can't match.

The standard power assisted front disc brakes snug the SR-5 to a clean stop, but there's hardly a pip from the tight, all-welded cab. And the standard AM/FM stereo radio, full carpeting, and blacked-out

instrument faces enhance the sporty atmosphere inside.

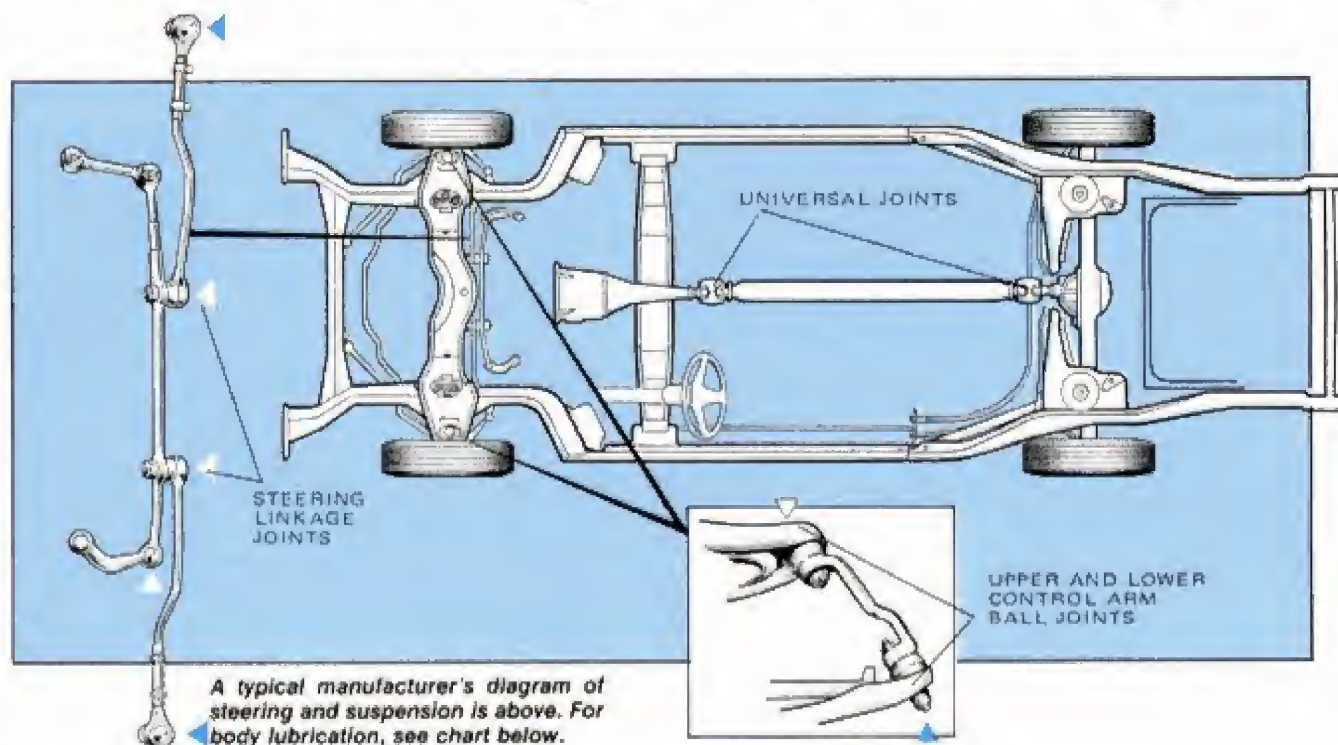
Everything working in harmony—that's the feeling the Toyota SR-5 Sport Truck shares with good sports cars. *PICKUP, VAN & 4WD Magazine* got the feeling. They put it this way, "...this is how a small truck built by BMW would drive and feel if BMW built small trucks."

THE SR-5 SPORT TRUCK.  
THE SPORTS CAR  
OF TRUCKS.





# 3. Servicing undercarriage



**U**ndercarriage maintenance refers to lubricating suspension ball joints and steering linkage fittings and, if called for, universal joints and the clutch cross shaft. Consult the lubrication diagram for your particular model (see sample, above).

Some manufacturers print such a diagram in the car's service manual while others provide it as a separate service pamphlet. The diagram pinpoints lubrication fittings. If it's not available, you will have to search for these fittings.

How often should a vehicle have a grease job? Consult the maintenance guide in your owner's manual. However, keep in mind that the interval given is a minimum recommendation and assumes ideal driving conditions. If you drive frequently in cold, snow, rain, extreme heat or dusty areas, the car will benefit from more frequent lubrication.

You need a hand-operated grease gun, which should come with an extension adapter to permit easy access to lubricating fittings. Newer grease guns accept cartridges of grease so that you don't have to pack the gun with grease from a bulk container.

Generally, manufacturers recommend grease containing molybdenum disulphide (so-called "moly" grease) for its long-lasting qualities. To provide even greater protection, the grease should be water-resistant.

### Ball joints, steering linkage

To properly lubricate ball joints and steering linkage, do the following:

**1. Raise and securely support the front of the car.**

**2. Find grease fittings and wipe them clean.** Some ball joints may have metal or rubber plugs rather than grease fittings. Remove plugs and insert fittings. After greasing components, you can either leave fittings in place or reinstall plugs.

**3. Engage each grease fitting, in turn, with the grease gun.** Pump the

you feel the rubber boot starting to swell.

■ Ball joints of Chrysler and General Motors cars expel grease through bleed holes at the base of the ball joint when the component has received ample grease.

■ If grease begins oozing between the tip of the grease gun and grease fitting as you start to lubricate a joint, stop pumping the grease gun. The fitting is probably blocked and should be replaced. Trying to force grease into a blocked fitting will only make a mess.

### Lubricating universal joints

Many U-joints, as they are called, are sealed and can't be greased. If the joints on the driveshaft of your car do require lubrication, put the car on safety stands at each of its four corners. Place the transmission in neutral and release the parking brake. This procedure assumes that you can't borrow the lift at a neighborhood service station for the few minutes it takes to do this job.

Turn the driveshaft by hand and find grease fittings. Wipe fittings off, attach the grease gun and apply grease until lubricant flows from the joint. Then wipe off the excess lubricant.

### Body lubrication

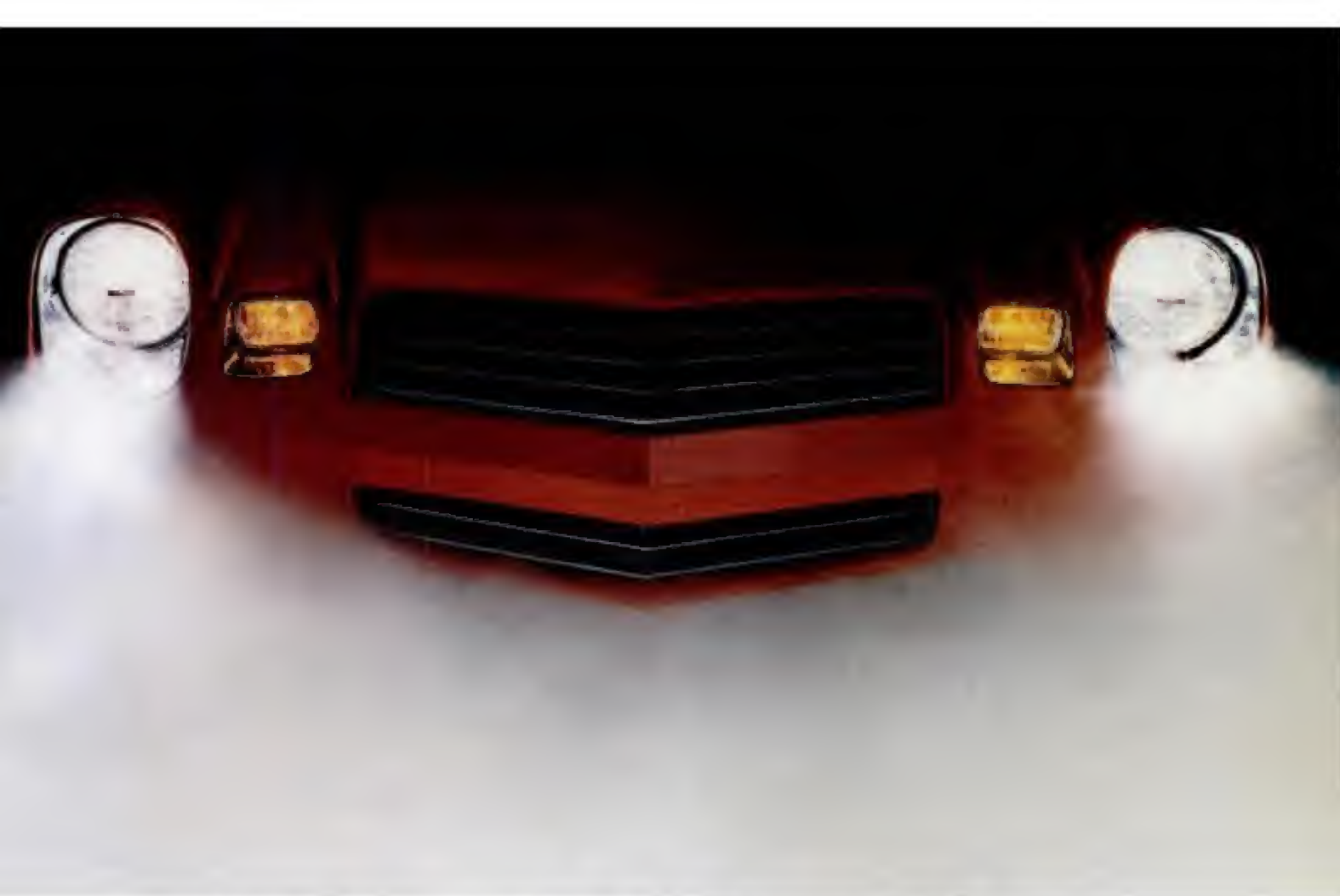
Lubricating body points is usually done when the undercarriage is greased. The chart (left) indicates these joints and suggests the type of lubricant you should apply to each.

Lubricating Point	Lubricant
Hood latch	Paraffin
Hood hinges	Oil
Vent window catch	Oil
Door striker plate	Grease
Door latch	Paraffin
Keyhole	Graphite or lock oil
Trunk lid hinges	Oil
Trunk lid lock	Oil
Trunk keyhole	Graphite or lock oil
Door stops	Paraffin
Door hinges	Grease
Front-seat slide rails	Paraffin and oil

handle slowly to apply grease. Stop lubricating when the ball joint is full; follow these tips:

■ Ball joints of American Motors and Ford cars should be lubricated until the rubber boot of the ball joint begins swelling. You can see the swelling begin, or you can place your hand on the boot and stop lubricating when





# A far sight better— GE halogen headlights.

GE Power Plus™ halogens are a far sight better for night driving than ordinary headlights. Compared to conventional headlights, they have twice the candlepower on high beam and can throw the light up to 25% further down the road.

GE halogens can cut through the dark and drizzle, take charge of the road and pull it into focus.



GE halogen headlight    Ordinary sealed beam headlight

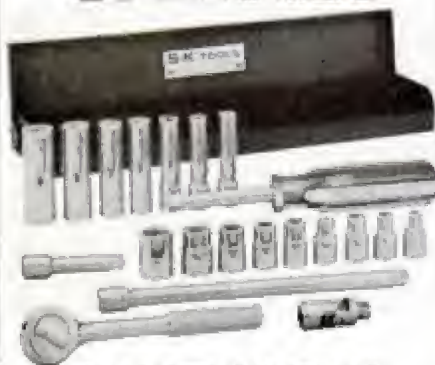
Install a pair of GE Power Plus halogen headlights today. They're a far sight better for night driving. Available wherever quality auto products are sold.

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**CHECK OUR GOLDEN WARRANTY**



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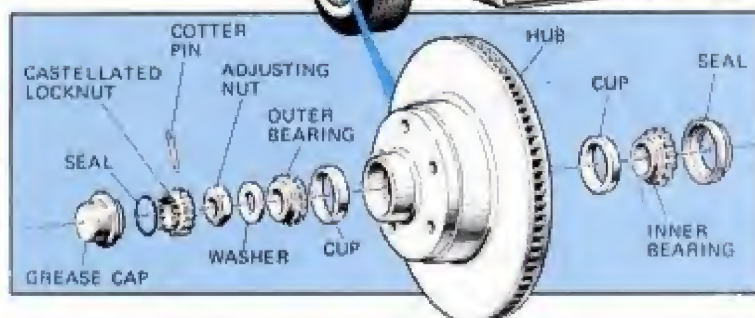
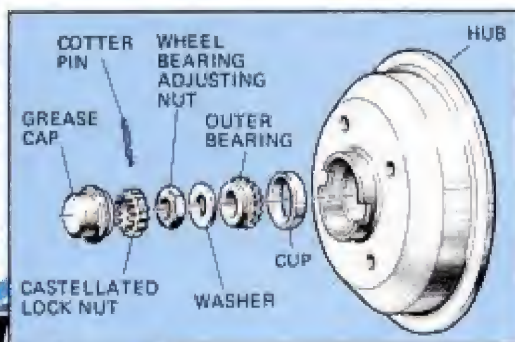
\*Savings are based on suggested user prices of  
individual pieces.

## CAR CARE GUIDE 1980

LUBRICATION

# 4. Lubricating wheel bearings

If the car has a rear differential, service the front wheel bearings. If it has a front transaxle, service the rear bearings. Follow manufacturer's schedule for the proper bearing-packing frequency.



**1. Jack up the car** and support the end you're working on with jack stands. Remove wheel covers.

**2. Use chalk to scribe a line** from the wheel onto the hub, if the wheel has disc brakes. These marks will allow you to put the wheel back in place so wheel balance is maintained.

**3. Loosen caliper retaining bolts**, if the wheel has disc brakes, and remove the caliper from the disc; support the caliper on a suspension member to keep stress off the brake hose.

**4. Remove grease cap.** If a castellated locknut is on the spindle, take it off.

**5. Straighten the cotter pin**, pull it out and throw it away. Remove the wheel-bearing adjusting nut and washer.

*Important:* All parts to be saved should be put on a sheet of clean, lint-free paper.

**6. Grasp the disc or the tire** of a wheel equipped with drum brakes. Free the

outer wheel bearing by pulling disc, or wheel-and-tire assembly, toward you, and pushing back. Bearing will drop on spindle.

**7. Remove the disc or wheel-and-tire assembly** and lay it face up on clean paper. Insert a brass drift or softwood dowel into the hub so it contacts the race of the inner wheel bearing. The race is the metal part that surrounds the rollers. Tap the inner bearing out of the disc or wheel. The grease retainer (seal) will also fall free. Throw it away. Remember which is the inner and which is the outer bearing.

**8. Wash bearings in a grease-cutting solvent**, working solvent between rollers with a clean, soft-bristle paintbrush. Use trichloroethylene as the solvent. It is not flammable. *Important:* Handle a bearing by its race to avoid dirtying it.

**9. Replace the bearing if it is damaged** (cracked, chipped or blackened). If it looks okay, spin it slowly to see if it rotates





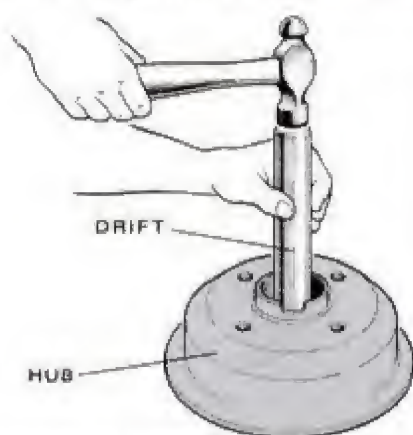
**Avoid contaminating a bearing by holding it by its metal outer edge, the race.**

smoothly. Discard the bearing if rollers feel gritty or bind as they are rotated. Don't worry, you can't overlubricate a bearing. If a wheel-bearing packing tool is not available, put on a pair of clean rubber gloves and scoop wheel-bearing grease into your palm. Knead bearing into grease, coating all surfaces.

**10. Clean the inside of the disc or wheel hub** with trichloroethylene after bearings are greased. Allow hub to dry; coat surface with thin layer of bearing grease.

**11. Turn the disc or wheel-assembly face down** and put the inner bearing inside the hub. Place a new seal over the bearing. Using a grease-seal installing tool or a soft brass drift, tap the seal into its seat.

**12. Clean the wheel spindle** and lubricate it with grease. Put the disc, or wheel-



**Remove the inner bearing and the grease seal by tapping a soft drift with a hammer.**

and-tire assembly, back on the spindle.

**13. Place the outer wheel bearing in the hub**, and install the washer and wheel-bearing adjusting nut.

**14. Tighten the wheel-bearing adjusting nut** to manufacturer's specs with a torque wrench as you spin the wheel. When the correct torque measurement is obtained, remove the wrench and see that the wheel revolves freely. If it does not, back off the nut about one-half turn. Test wheel spin again.

**15. Replace castellated locknut**, if there is one. Install new cotter pin.

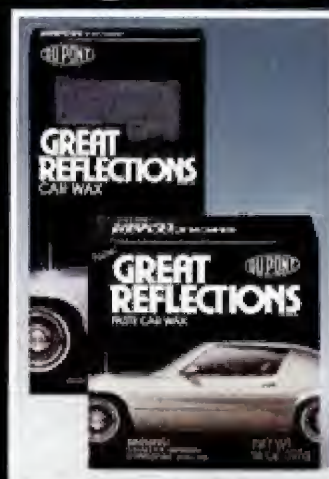
**16. Reinstall the caliper** of a disc-brake unit, and reinstall the wheel (line up wheel and hub chalk marks). **PM**



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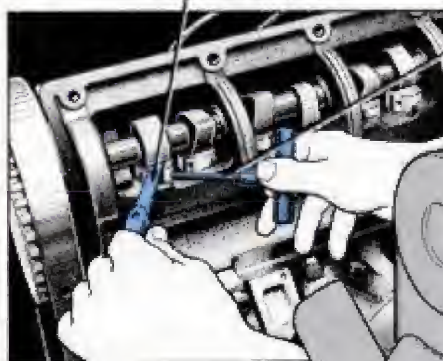
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## CAR CARE GUIDE 1980

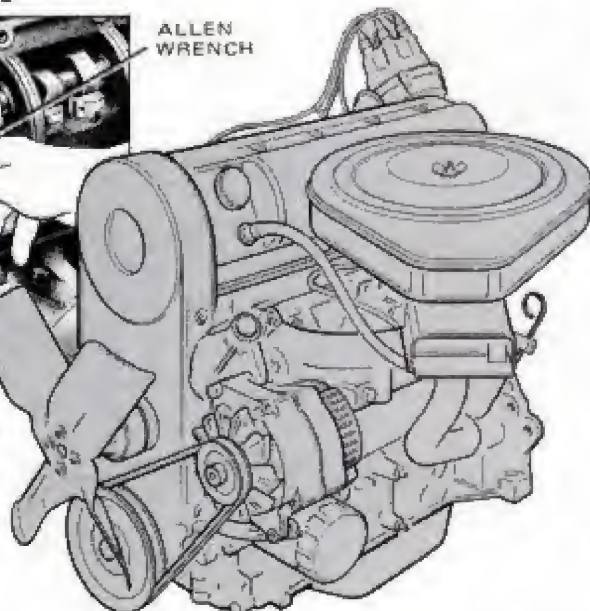
ENGINE

# 5. Adjusting valve

FEELER GAUGE



ALLEN  
WRENCH



To set valve clearance on GM ohc engine, use an Allen wrench to turn adjusting nut on the tappet. The feeler determines when correct clearance is reached.

The valves in most U.S.-built cars don't have to be adjusted, since valve clearance from the seat is maintained by hydraulic valve lifters. An exception is the 2000-cc Ford engine in the Pinto and Mustang II and Mercury Bobcat and Capri.

These valves are controlled by an overhead cam (ohc). Cam lobes of the camshaft press against fingers which, in turn, press against valve springs. The gaps between the cams and fingers should be measured and adjusted, if necessary, every 12 months or 12,000 miles, whichever comes first.

Another exception to the use of hydraulically activated valves is the four-cylinder engine used in Chevrolet Vega and Monza and Pontiac Astre and Sunbird from 1971 through 1975.

The gap between the cams of the camshaft and tappets should be measured and adjusted, if necessary, every 24 months or 30,000 miles.

There are other cars, mostly imported, that use adjustable valves. Although the task is done similarly on foreign cars, valve-clearance specifications differ from engine to engine. So consult the manufacturer's service data.

### Ford valve adjustment

**1. Remove the air cleaner.** Label the sparkplug cables so that you can reattach them to the correct plugs when finished. Remove the cables from sparkplugs and then remove the sparkplugs.

**2. Remove valve-cover bolts** and lift the valve cover off the engine, being careful that dirt doesn't fall into the engine. Discard the valve-cover gasket. Use a new one. Note that there are eight cams. Each one serves a valve, and each cam finger has an adjusting nut.

**3. Put the transmission in NEUTRAL** and attach a large wrench to the nut in the center of the crankshaft pulley. Turn the nut clockwise so that the pulley rotates clockwise until the lobe (high spot) of the No. 1 cam is straight down, pressing on the cam finger. This compresses the No. 1 valve spring.

**4. Disengage the cam retaining springs** from the grooves of cam fingers No. 6 and 7 using needle-nose pliers. The springs must be free of the fingers.

**5. Slide a feeler gauge** of correct size between cam No. 6 and cam finger No. 6, and then between cam No. 7 and cam finger No. 7. The feeler gauge should fit without force. If it doesn't (gap tends to decrease as valve parts wear), an adjustment is necessary. Valve adjustment for this engine should be done in the following sequence:

Depress valve (see Step 4)	Measure and adjust, if necessary, gap of cams
No. 1	6" and 7"
No. 2	3" and 8"
No. 3	2" and 5"
No. 6	4" and 1"

\*To 0.008 in.

\*\*To 0.010 in.

**6. Loosen the locknut** to make an adjustment. Then turn the adjusting nut until you can fit the specified size feeler gauge between the cam and cam finger. Turning the adjusting nut clockwise increases gap; counterclockwise decreases gap. The adjustment is correct when the gauge just fits the space and offers slight resistance as you move it in and out.

**7. Tighten the locknut.** Recheck the adjustment and put the retaining spring back in the groove on the cam finger. Check the other adjustments.

**8. Install a new gasket** and replace the cam cover when you have finished. Re-



# clearance

place the two front bolts first; then replace rear bolts. Tighten bolts securely.

## GM valve adjustment

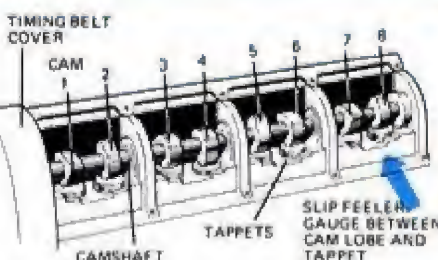
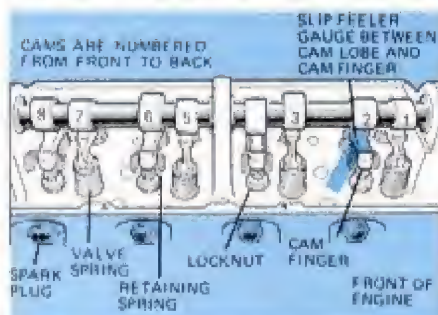
**1. Remove the air cleaner, spark-plug cables and sparkplugs.**

**2. Remove the valve-cover bolts and the valve cover.** Discard old gasket.

**3. Place the transmission in neutral** and engage the crankshaft-pulley nut with a large wrench. Turn the crankshaft pulley clockwise until the timing mark is at the midway point of the timing scale.

**4. Measure the gap between the cams and tappets** of No. 1, 2, 3 and 6 cams. The gap at No. 1 and 3 should be between 0.012 and 0.018 inch. The gap at No. 2 and 6 should be between 0.027 and 0.033 inch. With this engine, gap increases as valve parts wear.

**5. Rotate the tappet until the adjusting screw comes into view**, if the adjustment doesn't fall within specified



**Ford ohc engine (top) uses cam finger between lobe and valve stem. GM (above) uses tappet between lobe and valve.**

bounds. Insert a 1/8-inch Allen wrench into the adjusting screw and select a feeler gauge that will let you turn the screw at least one complete revolution. More revolutions are acceptable; less than one is not. With the feeler gauge in place, turn the adjusting screw clockwise to increase gap.

**6. Rotate the crankshaft pulley 180°** when you are done increasing the gaps at cams No. 1, 2, 3 and 6. The timing mark should be in a position opposite the timing scale. Now measure and adjust cams No. 4, 5, 7 and 8. Cams No. 4 and 7 should measure between 0.012 and 0.018 inch, and cams No. 5 and 8 should measure between 0.027 and 0.033 inch.

**8. Refit the valve cover.**

PM

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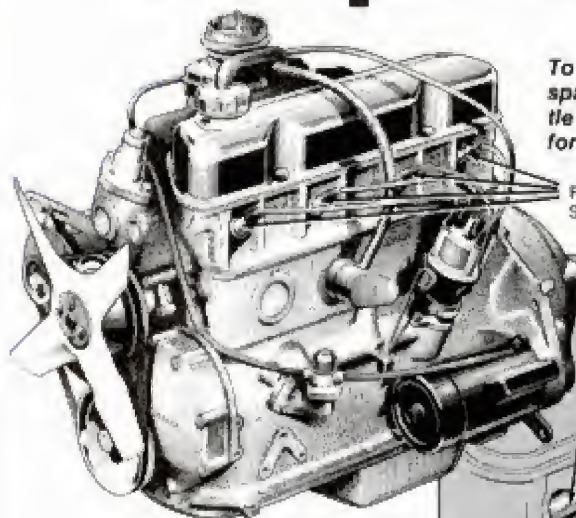
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## CAR CARE GUIDE 1980

## ENGINE

# 6. Testing cylinder compression



To test compression, remove all sparkplugs and jam open throttle plates. Test must be performed with a warm engine.

REMOVE ALL  
SPARKPLUGS

The compression and vacuum tests are diagnostic procedures for determining engine condition. The compression test determines whether piston-ring, valve or cylinder-chamber wear have progressed to a point where sealing qualities have been hampered, permitting loss of compression. If compression is lost, engine performance suffers. Most notably, there is a loss of power.

The compression tester (gauge) needed to do this job is available in two forms: push-in and screw-in. The push-in type, which generally costs less than the screw-in type, has to be held in place with both hands. This doesn't allow you to use a remote-control starter switch for cranking the engine; someone has to be available to turn the ignition inside the car. If the push-in compression gauge is not held firmly, there is a loss of pressure from around the gauge nozzle, which produces an erroneous reading. The screw-in compression gauge allows you to avoid this problem.

**1. Check that battery voltage is within acceptable bounds** and that engine oil is at the FULL mark on the dipstick. Warm up engine. Then turn it off.

**2. Remove sparkplugs.**

**3. Ground the ignition system** to avoid possible damage that cranking might cause. For all systems other than the General Motors High Energy Ignition (HEI), remove the high voltage cable from either the coil tower or the center tower of the distributor. Using a jumper wire with alligator clips soldered to each end, connect one clip to the metal terminal of the high-voltage cable. Connect the other clip to a clean metal spot on the engine, such as a bolthead or the alternator bracket.

If the car is equipped with the HEI system,

disconnect the main harness connector from the distributor cap to prevent damage.

**4. Be certain the choke plate is wide open** when the engine is warmed up. To make sure, remove the carburetor air cleaner. Then wedge the carburetor throttle plate(s) in the wide-open position. To do this:

- Have an assistant sit in the car to hold the accelerator pedal to the floor.
- Or, rotate the throttle lever on the carburetor and tie it back with wire.
- Or, cut a length of wood to jam between the front seat of the car and the accelerator pedal so the pedal is pushed to the floor.

**5. Connect the remote-control starter switch**, if you are using one, according to its instructions. Before using it, turn the ignition switch to ON to avoid damage to ignition-switch grounding circuit.

**6. Insert the compression gauge into a sparkplug port** and crank the engine until the gauge records the highest compression. Be sure the engine makes at least four revolutions. Do the same for all other cylinders, recording each compression mark.

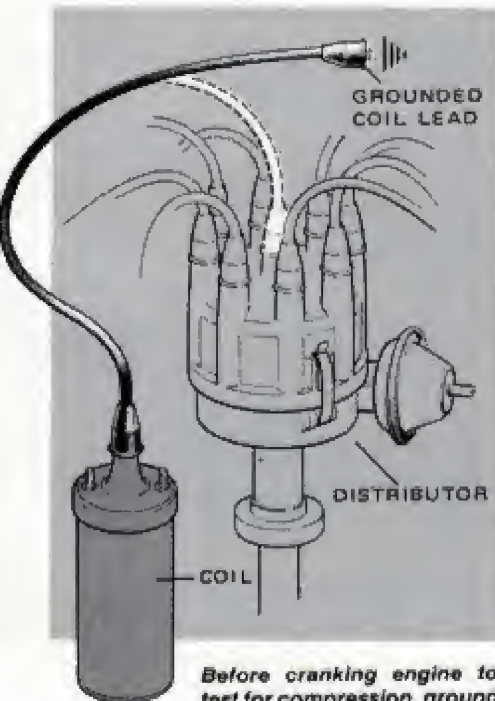
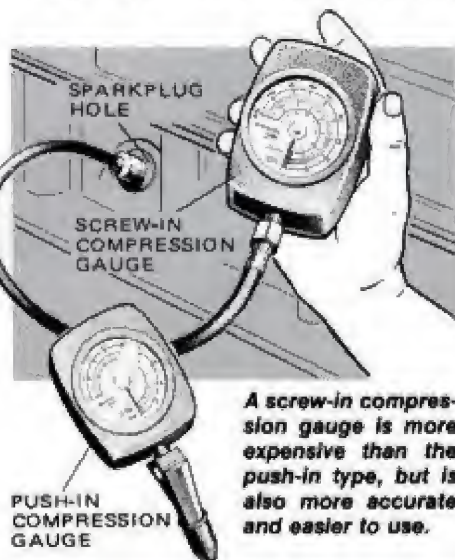
### Analyzing readings

Readings should be fairly uniform and none should be lower than 100 pounds per square inch (p.s.i.). Manufacturers have established compression specifications that should be consulted if any readings are not uniform. Generally, American Motors and General Motors state that a 20-p.s.i. variation between the highest- and lowest-reading cylinders is acceptable. Chrysler calls for a permissible variation between the highest- and lowest-reading cylinders of no more than 40 p.s.i. Ford says the variation must be within 75 percent. Thus, if the highest-reading cylinder of a Ford engine is 150 p.s.i., lowest-



reading should not be lower than 113 p.s.i. If compression readings vary too much, or are too low, determine which parts are causing the problem as follows:

1. **Squirt engine oil into the engine through the sparkplug ports.**
2. **Retest compression.**
3. **If readings improve,** piston rings are probably worn, although cylinder walls



also might be responsible for faulty compression. If readings don't improve, valves probably aren't sealing properly.

**Note:** If compression is low between adjacent cylinders, the cylinder-head gasket between the two may be damaged.

You may find that readings show too much compression—in excess of the manufacturer's maximum specification. Excessive compression shows carbon buildup leading to hard starting when engine is warm. **PM**

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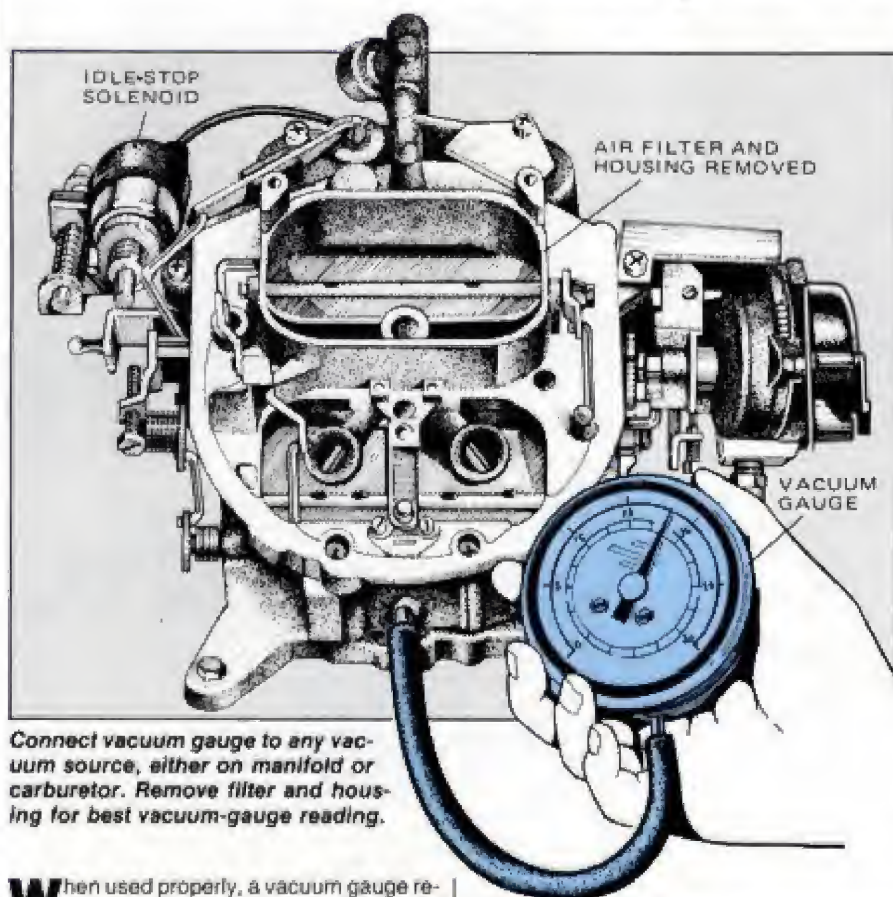
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# 7. Testing vacuum



Connect vacuum gauge to any vacuum source, either on manifold or carburetor. Remove filter and housing for best vacuum-gauge reading.

**W**hen used properly, a vacuum gauge reveals a great deal about the way an engine is functioning.

If an engine is running properly, the vacuum-gauge needle will hold steady at between 14 and 22 inches of mercury. You should check service literature to determine the correct vacuum-gauge reading for your engine, since there are variations from engine to engine and other factors that affect a reading, such as altitude. For each 1000 feet elevation above sea level at which a vacuum gauge is used, the vacuum reading is lowered by one inch of mercury.

It's important to note the vacuum-gauge reading, but you should also be aware of the action of the vacuum-gauge needle. A needle that vibrates, floats or drops suddenly indicates the engine is malfunctioning.

**1. Warm up the engine,** see that the battery is charged and make sure the engine is filled with the specified quantity of oil.

**2. Connect the vacuum gauge** to a source of intake-manifold vacuum. If there is no vacuum port on the engine, connect the gauge to the port at the base of the carburetor to which the choke vacuum break connects.

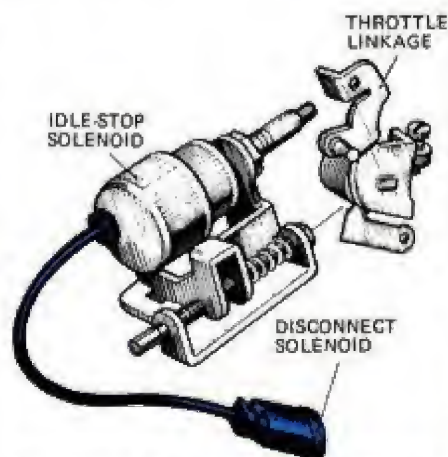
Another spot to connect the gauge is the port at the base of the carburetor for the hose from the vacuum motor of the thermostatic air cleaner.

**3. Run the engine,** noting the action of the vacuum-gauge needle. One of the readings on the chart (below) will apply to your situation.

**4. Shut off the engine and ground the ignition system** as you did to make the compression test (see *Testing Cylinder Compression*, page 158).

### WHAT A VACUUM GAUGE TELLS

Reading	Interpretation
Needle steady at correct specifications.	Engine running perfectly.
Needle drops 1 in. or more, returns to normal, drops, etc.	Intake valve malfunction.
Needle vibrates excessively.	Leaking head gasket.
Needle steady at 3 to 8 in. below normal.	Intake system leak.
Needle wavers over 5-in. range.	Carburetor adjustment.
Needle drops to zero as engine speed increases.	Clogged exhaust system, or stuck heat-control valve.
Low, steady reading.	Incorrect ignition or valve timing.
Needle pulsates unevenly.	Bad valves, worn rings, damaged piston or blown head gasket.
Reading below 5 in. of Hg.	Engine compression low, incorrect valve timing or vacuum leak.



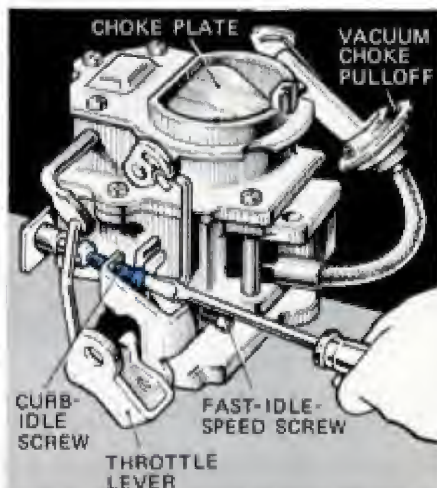
Disconnect the wire lead of idle-stop solenoid before testing engine vacuum.

**5. Disconnect the electric lead wire** to the idle-stop solenoid to close the carburetor throttle valve(s).

If the carburetor doesn't have an idle-stop solenoid, turn the idle-speed adjustment screw counterclockwise until the throttle valve(s) is completely closed. Count the number of turns so that you can return the idle-speed adjustment screw to its original position later. The throttle valve(s) must be closed to avoid an inaccurate vacuum-gauge indication.

**6. Remove the PCV valve** from its seat. As someone in the car cranks the engine, hold your thumb over the end of the positive crankcase ventilation (PCV) valve to prevent a loss of vacuum and note the action of the vacuum-gauge needle. If your reading appears on the chart below, you have uncovered a problem that should be repaired as soon as possible.

PM



Turn curb idle screw counterclockwise until throttle valve is fully closed.



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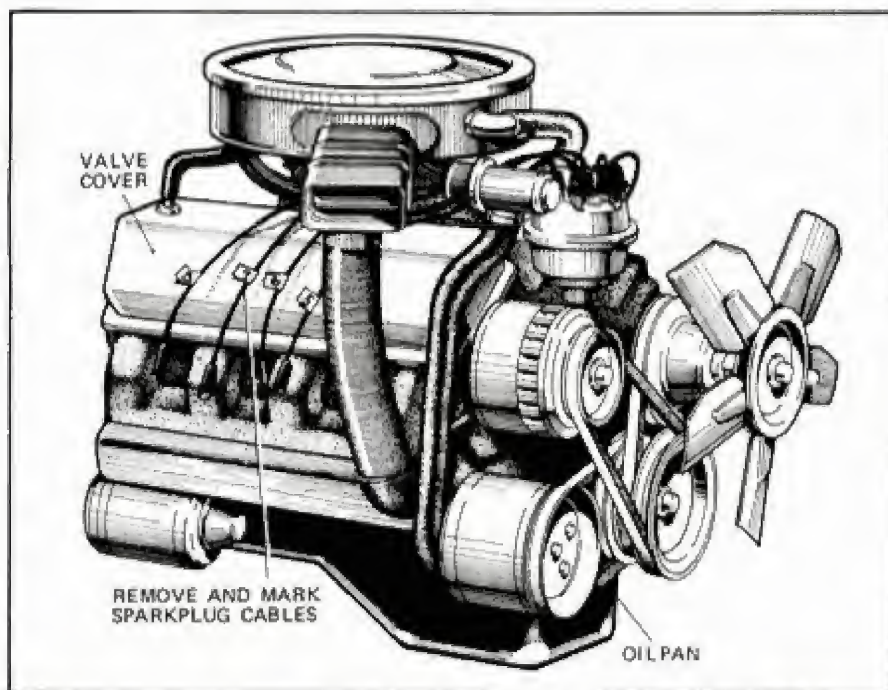
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# 8. Replacing gaskets



Before removing valve cover, disconnect and mark the sparkplug cables. Depending on the model, you might have to remove a chassis cross member to drop the oilpan.

**M**ost engine oil leaks come from around the oil filter, oilpan or valve cover(s). Oil leaks from around the filter are discussed in *Replacing an Oil Filter* (see page 150).

Oil will leak from around the oilpan and valve cover if retaining bolts loosen or gaskets deteriorate. Rarely, a sharp object may puncture the pan, causing a leak.

Let's assume that tightening bolts has not stopped a leak. Remove the oilpan or valve cover to replace gaskets (or to replace the oilpan if it is damaged).

### Oilpan gasket

**1. Raise the car** and make sure it is adequately supported. Do not work under a car held up by bumper jacks alone. Use jack stands or work with all four wheels on the ground.

**2. Drain the oil.**

**3. Remove oilpan bolts.** Use a putty knife as a wedge, if necessary, to pry the pan loose from the engine, and drop the pan.

**4. Clean the pan.** Now is a good time to examine the bottom of the pan for foreign matter, such as metal filings which may indicate engine damage.

**5. Scrape off old gasket material** from the lip of the pan and from the engine block. The pan and block must be clean.

**6. Check to see if bolt holes are deformed.** If they are, they will allow oil to leak. So replace the pan.

*Note:* Oilpans are usually sealed to the block with a cork gasket. Some late-model

cars use a liquid silicone sealer. Use either method.

**7. Get the correct replacement**—one that fits the pan—if you're using a cork gasket. Apply a dab of rubber adhesive sealant to each corner of the gasket and place the gasket on the lip of the pan. The adhesive sealant keeps the gasket in place as the pan is put against the block and the bolts are tightened.

**8. Apply a bead of silicone sealer** about  $\frac{3}{16}$ -inch wide around the pan or engine block (not both). Make sure the sealer is the correct kind for oilpans—able to withstand heat. The sealer must be applied inboard of the bolt holes and not plug them. Lift the pan into place.

**9. Install and tighten bolts evenly.** Do not overtighten. You may warp the pan.



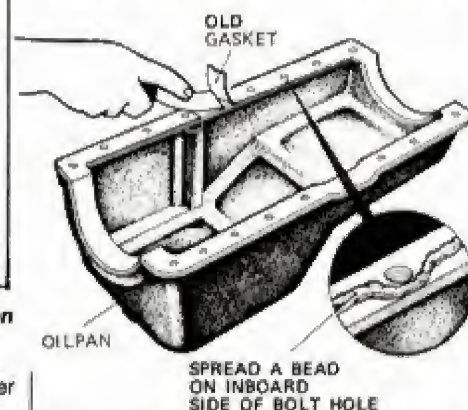
To fix a warped valve cover, place it on level surface and tap edge with a hammer.

**10. Fill the pan with oil** and check for leaks. If you find a leak, tighten bolts until the leak stops.

### Valve-cover gasket

**1. Remove the oil dipstick** and, if necessary, remove the sparkplug-cable support bracket after disconnecting cables. If you disconnect cables from sparkplugs, be sure to identify each for the plug it serves.

**2. Disconnect and remove hoses,** lines or parts lying over or in the valve cover.



Scrape off old gasket with a putty knife; clean surface of the oilpan with a solvent.

such as the positive crankcase ventilation (PCV) valve.

**3. Remove valve-cover retaining bolts.**

**4. Strike the base of the cover** gently with a hammer to break the cover free. Lift off the cover.

**5. Scrape old gasket material** from the lip of the valve cover and from the engine. Check the cover for damage, especially for deformed bolt holes. Replace a damaged cover.

*Note:* Generally, valve-cover gaskets are cork, but late-model cars use a gel gasket. You may use either.

**6. Apply gasket adhesive sealer** around the lip of the cover if you use a cork gasket. Don't use too much and don't block bolt holes. Place the new gasket so holes line up with bolt holes in the cover. See that the locating tab, if there is one, is set into the locating-tab notch. Set the cover.

**7. Apply a bead of gel,** if you use a gel gasket, about  $\frac{3}{16}$ -inch wide around the lip of the cover, inboard of bolt holes. Make sure gel doesn't block holes. Replace cover.

**8. Tighten bolts until they are snug.** Then, give them an additional one-half turn. After you are done, start the engine and check for leaks.

FM



# 2. Testing plug cables

**N**ew sparkplugs and an ignition tuned to perfection make for super engine operation. However, between an ignition system and sparkplugs are the cables, and unless these are in good shape, the best ignition system and plugs in the world will be useless.

Damaged cables are one of the main reasons for inadequate delivery of current to the sparkplugs. This can cause engine misfire, and an increase in fuel consumption and emissions. It may also result in an engine not starting at all.

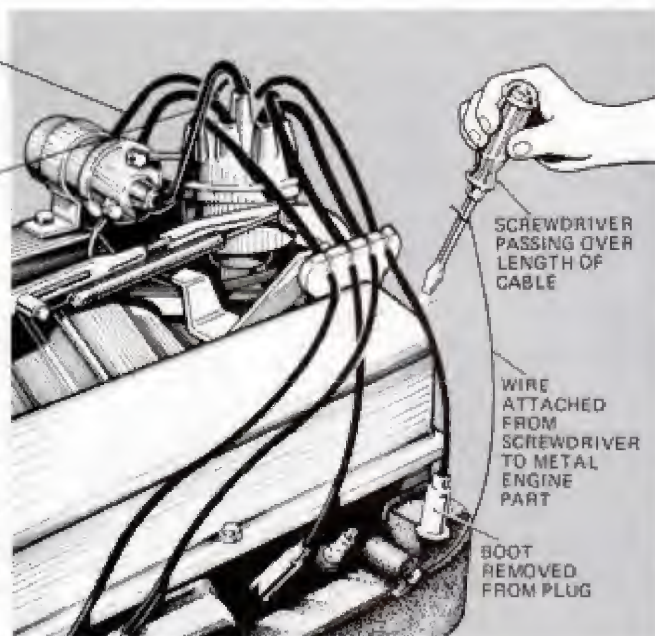
Cables are subjected to high voltage and high temperature. They don't last forever. To find out how the cables in your car are doing, inspect them visually and perform current-leakage and resistance tests.

Discard cables that don't pass an examination and tests. However, just because some cables fail, all cables don't have to be replaced. Keep those that pass tests in service, but be aware of the fact that they're older. You should, therefore, test them more often.

CHECK FOR LOOSE OR CORRODED TERMINALS, CRACKED OR FRAYED CABLES

COIL-TO-DISTRIBUTOR CABLE

*To test for leakage, attach a wire between screwdriver and metal engine part. Start the engine and disconnect one cable at a time. Pass the screwdriver over length of cable. If spark should jump from the cable to screwdriver, cable is broken internally and should be replaced.*



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## Leakage test

**1. Mark each cable with its respective cylinder number.** Cables must be reconnected to the correct cylinders to avoid possible engine damage.

**2. Disconnect cables at spark-plugs with cable pliers.** If sparkplug-cable pliers are not available, grasp the cable boot and twist it back and forth, pulling it free. *Caution:* Do not pull the cable. Pulling at the cable will break the wires inside.

**3. Bend each cable back and forth** over its length, looking for cracks, burned areas and brittleness. Replace a cable that fails to pass inspection. Replace the cable if one of the boots is damaged. If the cable is okay, wipe it off with a rag to remove oil, grease and other dirt, and reconnect it.

*Important:* Don't forget to inspect the cable from the center tower of the distributor to the ignition-coil tower—probably the most important cable of all. If any of the other cables fail, the engine will misfire, but it will run. If the distributor-to-coil cable fails, the engine won't run at all.

**4. Reconnect all cables.** Connect one end of a jumper wire to a screwdriver. Connect the other end of the jumper wire to a metal part of the engine. Start the engine.

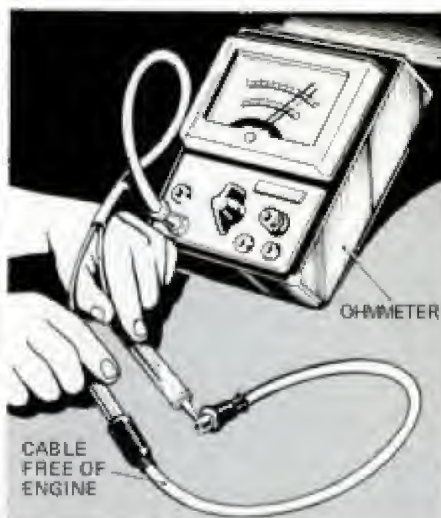
Now, remove one cable from a sparkplug and pass the tip of the screwdriver along the full length of the cable, from boot at the spark-

plug to boot at the distributor. Hold the tip of the screwdriver about 1/8 inch from the cable. If a spark jumps from the cable to the screwdriver, there's a break in the cable. Replace the cable. If the cable passes the test, reconnect it. Following this procedure, test the rest of the cables.

**5. Leave the last sparkplug you tested disconnected,** and pass the screwdriver over the ignition coil-to-distributor cable. If you disconnected this cable for testing, the engine would stop running and you wouldn't be able to do the test. Leaving a sparkplug cable disconnected sets up enough resistance in the ignition system to short circuit the current passing through the ignition coil-to-distributor cable if it was damaged.

**6. Turn off the engine.** Remove one sparkplug cable and measure it with a ruler. Connect an ohmmeter between the two ends of the cable, making sure that contact between ohmmeter probes and cable terminals is secure. If the cable is less than 25 inches long, the ohmmeter should not register more than 30,000 ohms. If the reading is greater than this, the resistance is excessive and you should replace the cable. If the cable measures 25 inches or longer, the ohmmeter should not show a reading of more than 50,000 ohms.

*Caution:* In reconnecting cables to spark-



**If a cable is under 25 inches long, the resistance should be below 30,000 ohms.**

plugs, distributor and ignition coil, make sure the connections are tight. If not, the current will arc and burn terminals. To connect cables to the distributor and coil tower, squeeze boots as you push and twist the terminals into place. Squeezing boots releases trapped air.

PM

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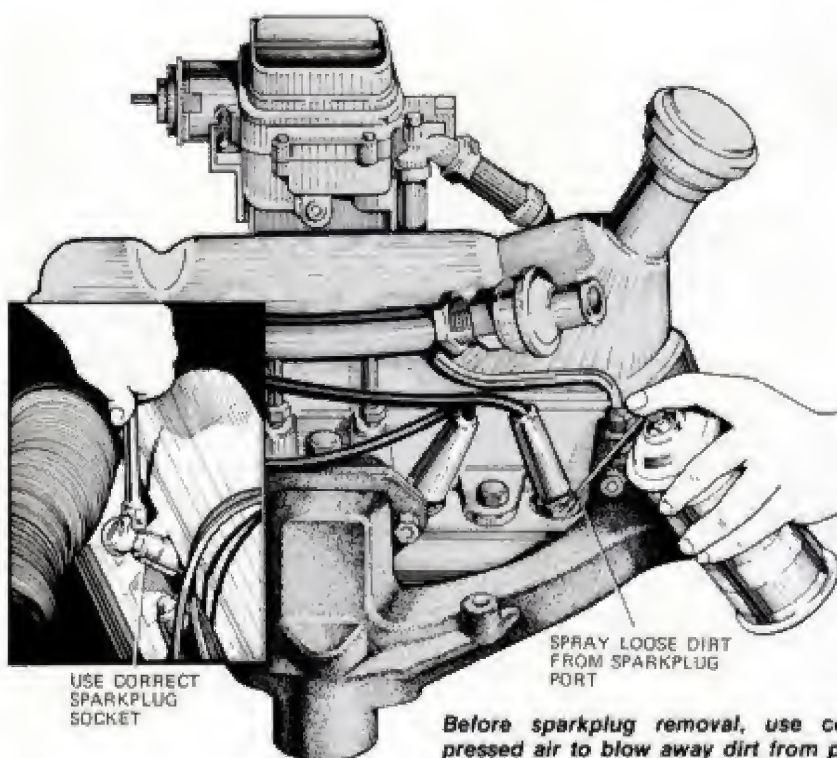
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## CAR CARE GUIDE 1980

### IGNITION SYSTEM

## 10. Servicing



Before sparkplug removal, use compressed air to blow away dirt from plug port. Use proper socket to remove plug.

**G**ood sparkplugs are the key to good engine performance and mileage. They are also a valuable diagnostic tool. They can reveal the existence of an engine problem and cure it before it becomes critical. To service sparkplugs, follow this procedure:

- 1. Label sparkplug cables** so cables can be reconnected to their respective plugs. Use masking tape or clip-type clothes pins for labeling. Also, label each plug as you remove it from the engine. Cables must be reconnected to their correct cylinders to avert possible engine damage. Identifying sparkplugs allows you to diagnose cylinder performance through sparkplug appearance.

- 2. Loosen plugs using a ratchet wrench** and a properly sized sparkplug socket.

*Important:* First, just loosen plugs. Do not remove them from the engine.

- 3. Blow dirt from around the sparkplugs** to make sure no particles fall inside the engine. Use a can of compressed air for best results.

- 4. Remove the plugs.**

- 5. Examine each sparkplug.** Listed at the end of this section are sparkplug conditions that indicate how your engine is operating.

- 6. If sparkplugs can be reused,** wash them in solvent, using a stiff bristle brush. Don't use a wire brush. It will damage electrodes and the insulator. Allow the plugs

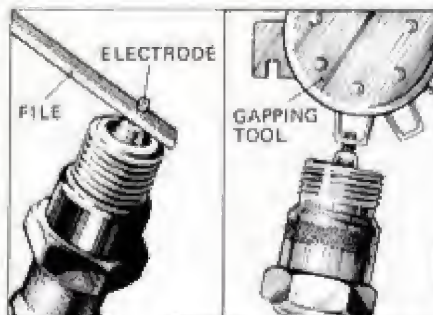
to dry. If possible, clean the plugs in a sparkplug-cleaning machine.

- 7. Open the side electrode of each plug.** Do not use pliers, and do not bend the center electrode. Any tool other than an electrode-bending tool will probably damage plugs.

- 8. File electrodes** with an ignition-point file until their surfaces are flat and edges are sharp. Don't file any more than necessary.

- 9. Discard old plug gaskets** and replace them with new ones to avoid compression leaks. Old gaskets are too crushed to be reused.

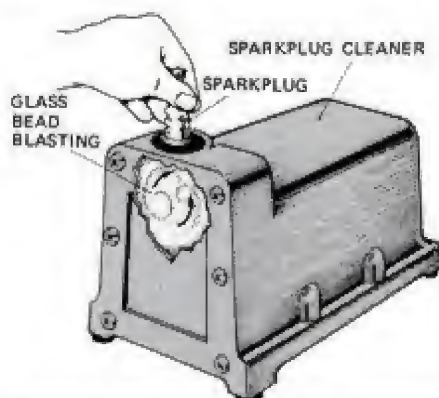
- 10. Set electrode gap** according to



File electrode with ignition-point file. Set gap with combination gapping tool.



# sparkplugs



*Portable sparkplug cleaner is the best way to clean electrodes and restore plugs.*

the specification recommended for your engine by the manufacturer. Gap is set properly when there is slight resistance on the specified-size feeler gauge, as you move the gauge back and forth between electrodes.

**11. Screw plugs back into the engine** by hand until they are tight. If you have a torque wrench, tighten plugs to the specification given in the manual. If you don't have a torque wrench, give plugs with gaskets an additional one-quarter turn with a conventional sparkplug wrench. If plugs have tapered seats (no gaskets), tighten them an additional  $\frac{1}{8}$  turn.

## Reading a sparkplug

- Brown or grayish-tan and slight electrode wear: This is normal. Keep the plugs.
- Eroded electrodes, and dark and pitted insulator: This is normal when plugs have reached the end of service. Discard them.
- White or yellow deposits: This is the result of additives put in gasoline. Clean and service plugs, and return them to use.
- Spotting on insulator: This is the result of cylinder deposits that have melted and splashed on the insulator. Clean and service plugs, and return them to use.
- Oily black deposits: Look for internal engine wear, a leaking brake power-assist unit, or a leaking transmission modulator. Discard plugs.
- Dry black deposits: Look for an excessively rich fuel mixture or clogged air-cleaner filter. Sparkplugs may be too cold for the slow, city-type driving in which the car is being subjected. Discard plugs.
- Eroded electrodes and white, blistered insulator: Look for engine overheating, wrong timing or an excessively lean fuel mixture. Sparkplugs may be too hot for the type of vehicle operation. Discard plugs.
- Melted electrodes: Look for crossed sparkplug cables or any condition that causes preignition. Discard plugs. **PM**

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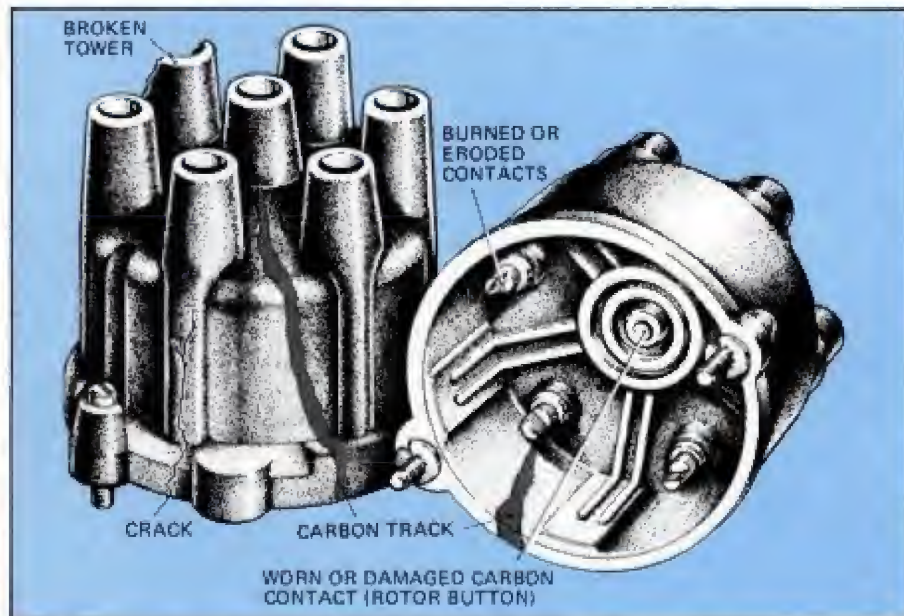
\*Shaved to 1/2 tread depth

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# 11. Servicing distributor



These are some of the physical problems that can plague a distributor cap. There is no way to repair the damage. You should replace the distributor cap with a new one.

A damaged cap or rotor is responsible for a variety of performance problems, including engines failing to start or being hard to start and engines misfiring, especially in damp weather. The following information explains how to examine a distributor cap and rotor for damage.

### Inspecting the cap

**1. Remove the distributor cap.** Caps are held by one of three fastening methods: spring clips, L-shaped latches or slotted screws. To release spring clips, insert the tip of a screwdriver behind the clips and twist until clips snap loose. To release L-shaped latches, engage the heads of the latches with a screwdriver, press down and turn one-half turn. To release slotted screws, engage screws with a screwdriver and remove them. Lift off the cover.

**2. Wipe the inside and outside of the cap** with clean rag or paper towels.

**3. Turn the cap upside down**, so you can inspect the inside. Look for:

- Badly pitted, eroded or burned (black or blue in color) contacts.
- Worn carbon contact. This is the contact in the center of the cap. If it is worn so it is flush with the body of the cap, replace the cap.
- Cracks or fractures.
- Lines of carbon (carbon tracks) between terminals. A carbon track indicates a crack in the cap.

**4. Turn the cap right side up.** Remove each cable by grasping the cable boot and pulling it off with a slow, twisting action. Do not pull on the cable; you will damage it. Look for:

- Broken distributor towers.
- Cracks.
- Carbon tracks.

**5. Clean out the distributor tower** with a distributor cleaning tool. To reconnect the cable, place the boot on the tower, twist the cable as you press down and squeeze the boot to release trapped air.

**6. If the distributor cap** shows any evidence of the above damage, replace it.

### Replacing a distributor cap

To keep cables from being reversed proceed as follows:

**1. Place the new cap next to the old one** so markings on the two caps are in the same relative positions.

**2. Remove one cable at a time** from the old cap and install it in its proper position in the new cap.

**3. Install the new cap on the distributor** after all cables are in place, and discard the old cap. Start the engine. If the engine runs rough or backfires, you have probably reversed a cable. Consult a service manual for the engine firing order and correct the placement of cables. This should not happen if you follow our instructions.

### Inspecting the rotor

**1. Most rotors**, except those in General Motors distributors, are removed by pulling them straight up. GM rotors are held by two screws, one on each side. To take off a GM rotor, remove the screws.

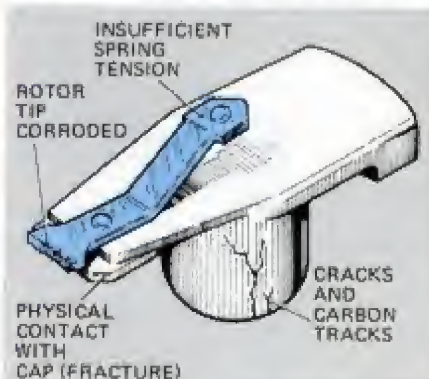
**2. Look for:**

- Fractures.
- Cracks.
- Carbon tracks.

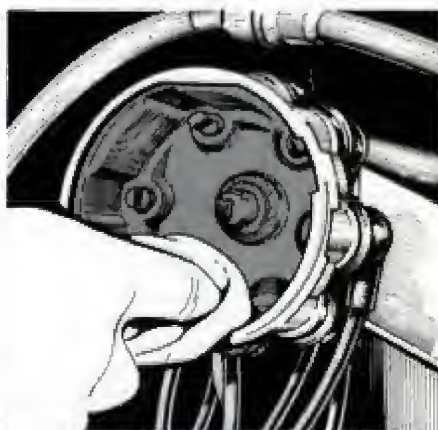
- Badly burned (black or blue in color) or eroded metal contact.
- Loose spring (lack of tension).

**3. Replace a damaged rotor.** Be sure to get the right rotor for your distributor. Some rotors look the same, but have different dimensions. A wrong rotor won't work. Be sure the rotor is properly seated on the distributor shaft.

**Note:** The electronic ignition systems of 1977 and later model Ford Motor Co. cars have a silicone dielectric compound spread on the tip of the rotor and on the terminals of the distributor cap. This compound eliminates ignition interference with radio reception. Don't wipe it off if the cap and rotor are



Due to constant friction, the rotor tip is usually the first part that will fail.



If the cap is in good shape, wipe it clean before replacing it on the distributor.

reused. When buying a new rotor and cap, see that the compound has been applied. If not, get a tube and coat the rotor tip and distributor cap terminals with a thin layer.

While you are replacing the cables in the new distributor cap, inspect cable terminals for corrosion. If the terminals are only slightly rusted, they can be cleaned with emery cloth and returned to service. If they are severely rusted or corroded, you should install new terminals. **FM**



# 12. Adjusting breaker points

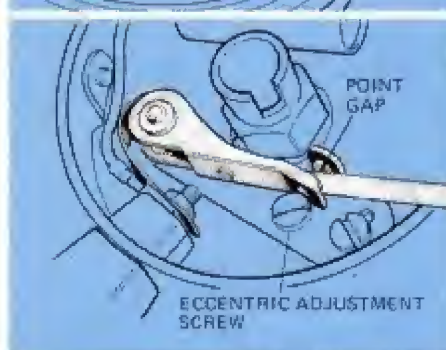
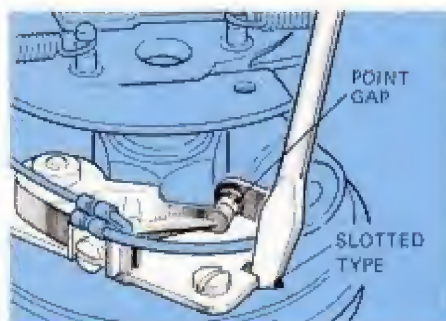
**D**istributor points eventually deteriorate by burning, pitting and eroding. And the gap between them changes as the points wear, and as the rubbing block that moves on the distributor cam wears down. As the block wears, the gap gets smaller.

Worn points or too small a point gap makes starting difficult and sometimes impossible. Bad points will also cause an engine to stall, run roughly and lose power. To avoid such problems, points should be replaced every 10,000 to 15,000 miles.

At the same time you replace points, replace the condenser. The condenser absorbs surges of electricity and prevents electric arcing across points.

### Procedure to follow

1. Remove the distributor cap and rotor.
2. Examine the points and make note of how the wire from the condenser is attached. In most distributors, this wire and the wire from the ignition coil are attached together on the breaker-point assembly leaf spring. Remove the nut holding the wires and



separate them. Be sure to keep the fasteners in order, so you can replace them properly.

3. Remove the screw, or screws, holding the breaker-point assembly. Don't lose the screw lock washers, if there are any. They have to be reused. Lift out the points.

4. Remove the screw holding the condenser. Lift out the condenser and install a new one.

5. Install a new set of points, but don't tighten the hold-down screws.

6. Reattach the condenser and coil wire to the leaf spring.

7. Draw a reference mark with chalk on the distributor and engine in cars other than those that are GM V8s. Loosen the distributor hold-down bolt and turn the distributor until the distributor point rubbing block is

To adjust points on non-GM distributors, use a screwdriver to twist a slot or to turn an adjusting screw. The feeler gauge should be snug, but not tight, when setting gap.

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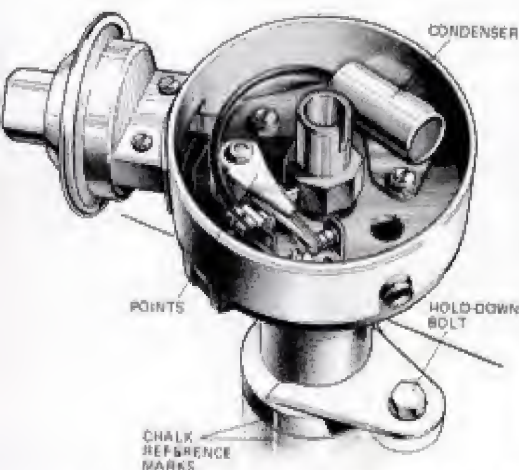
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on one of the high points of the distributor cam. Gap points with the correct-size feeler gauge by inserting a screwdriver into the screw or slot, depending on the type of distributor, next to the mounting screw. Turn or twist the tip of the screwdriver until the points open slightly wider than the thickness of the feeler gauge.

Insert the gauge between the points. Hold



Turn distributor until the rubbing block is at a high point on the distributor cam.

the gauge with sides parallel—don't twist it. Now, close the points on the feeler gauge until you feel a slight resistance as you move the gauge in and out between the points.

**Caution:** The feeler gauge must be clean. Dirt transferred to the points will cause them to fail prematurely.

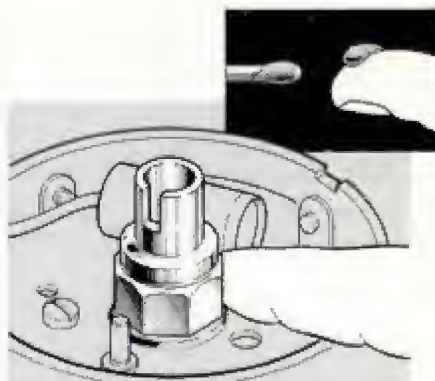
With the gap set, remove the gauge and tighten the point mounting screw. Now, double check the gap setting. If it has changed substantially, you should repeat the adjustment procedure.

**8. Squirt some lighter fluid** or alcohol on a lint-free towel and draw the towel through the points to remove any oil or dirt.

**9. Return the distributor** to its original position by aligning chalk marks on the distributor and engine. Tighten the hold-down bolt.

Steps 7, 8 and 9 are not necessary for a General Motors V8 car. GM points are pre-set. However, GM distributors, as well as all others, should be lubricated.

**10. Replace the lubricating pad** that presses against the distributor cam. Do not lubricate the pad and keep it in use. If there is no pad, put a drop of distributor cam grease, about the size of a match head, on a high point of the cam. Only one drop on one high point is needed. Overlubricating the cam may cause grease to splash on points, which will burn them.



When lubricating the cam, use just a small drop on only one of the high points.

**11. Examine the center of the distributor shaft.** If there is a pad, lubricate it with two drops of medium-weight household oil.

**12. Reinstall the rotor** and distributor cap. Set point dwell.

If you find that your points need frequent adjustment, there's a good possibility that the entire distributor must be overhauled. This means you must remove the distributor and then test it on a distributor-analyzing machine.

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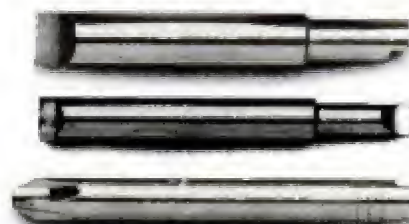


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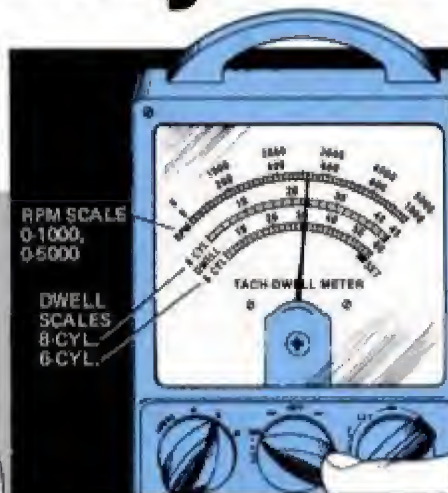
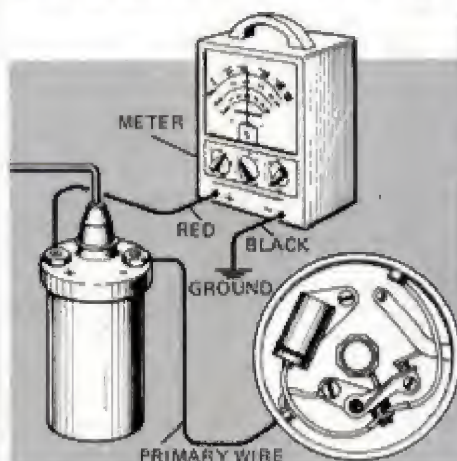


# CAR CARE GUIDE 1980

## IGNITION SYSTEM

### 13. Setting dwell

*A dwell/tach meter provides the only accurate way of setting correct dwell angle. Feeler gauge method isn't good enough.*



**D**well angle is the distance the distributor cam rotates while distributor breaker points are closed. If the points stay open for too short or too long a period, current transmitted to sparkplugs is disrupted and the engine won't run properly.

Setting breaker-point gap by measuring dwell angle is the most accurate method. Using only a feeler gauge is hit-or-miss. Dwell angle is measured in degrees by using a dwellmeter.

#### How it works

The dwellmeter is a voltmeter calibrated to record voltage passing through the ignition-system primary circuit as breaker points open and close.

If points remain closed for too short a time, voltage shown will be relatively low. If points remain opened too long, voltage will be relatively high.

Every automobile maker specifies the dwell for the distributor points of its models. This specification, which differs from car to car, is normally given as a range, such as 16° to 18°. Setting dwell to any figure in this range is acceptable.

The dwellmeter is normally combined with a tachometer in one instrument referred to as a tach/dwell. The tachometer allows you to measure engine speed in revolutions per minute. The tach is a convenience feature, since point dwell has to be set with the engine

running at the speed specified by the manufacturer. You can switch from dwell function to tach function, and back again.

A tach/dwell usually possesses a cylinder-selector switch. Depending on the engine, the switch is placed in either the six or eight position. If your engine has four cylinders, place the switch on the eight-cylinder function and double the reading.

#### Test procedure

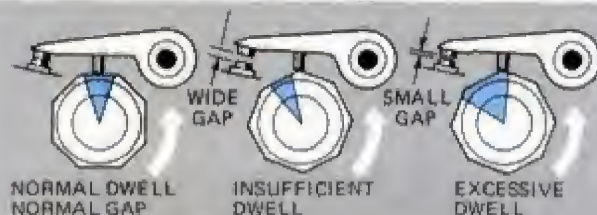
**Note:** There is no dwell adjustment to make with electronic-ignition distributors, which have no breaker points.

**1. Connect the tach/dwell,** following instructions accompanying the instrument. Instructions supplied with the meter will probably say to connect the tach/dwell red wire to the side terminal of the ignition coil (the terminal to which the coil-to-distributor primary wire is attached).

Attach the other tach/dwell wire (the ground), usually black, to a clean metal part on the engine.

**2. Switch to tach function,** start the engine and check engine idling speed. If it does not conform to manufacturer specification, you should set the engine to the correct idling speed.

**3. Switch to dwell function.** To set the dwell angle on a General Motors V8 distributor, leave the engine running and lift the sliding window on the side of the distributor



*Dwell angle is the distance that cam rotates while the points are closed. The initial setting is made with a feeler gauge with the points open. The setting should then be checked with meter.*

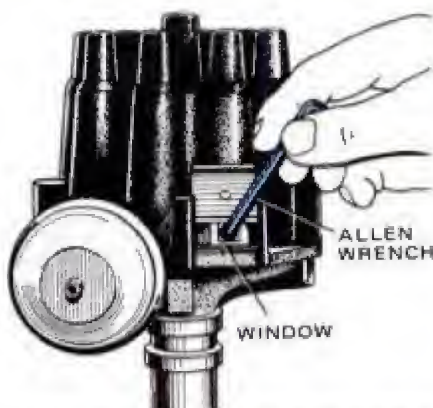


# angle

cap to expose the breaker-point adjustment screw.

Engage the adjustment screw with an Allen wrench and slowly turn the screw as you watch the dwellmeter scale. Turn the screw clockwise to reduce dwell angle and counter-clockwise to increase dwell angle. When the dwellmeter indicates the specified dwell angle, remove the Allen wrench. Make sure you close the window; leaving it ajar will allow dirt and fumes to get inside the distributor and contaminate breaker points. Turn off the engine and disconnect the tach/dwell.

To set dwell angle of a distributor that doesn't have a window, turn off the engine, remove the distributor cap and rotor and set



On GM V8 distributors, set dwell angle by opening window and using Allen wrench.

breaker-point gap with a feeler gauge. If the dwell angle is too small, move points closer together. If the angle is too large, move points farther apart.

Reinstall the rotor and distributor cap. Start the engine and check dwell angle again. You may have to repeat this a couple of times until the specified dwell angle is locked in. When points are properly adjusted, turn off the engine and disconnect the tach/dwell.

#### 4. After setting distributor point dwell, check and adjust ignition timing.

If you find your breaker points are burning up, pitting or corroding prematurely, examine the electrical system to make sure that points are not receiving excessive voltage which will serve to cause all of the above mentioned problems.

Moisture can also wear out points prematurely. To avoid it, be sure the distributor cap fits properly and sparkplug cable boots are fully seated.

Moisture in the distributor can also prevent your car from starting. If your distributor is in sound shape, yet you still have a starting problem in damp weather, the cure is in an aerosol spray that dries out wires. It's sold under several brand names, but is commonly called wire dryer. **PM**

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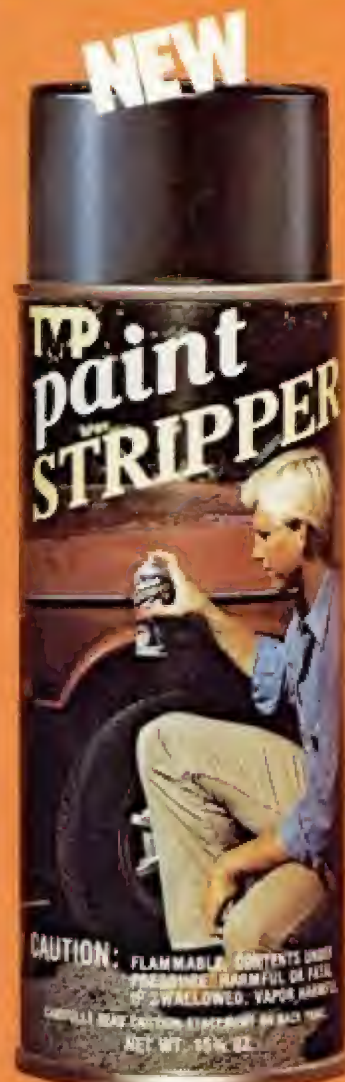
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### STEP FORWARD INTO THE PAST



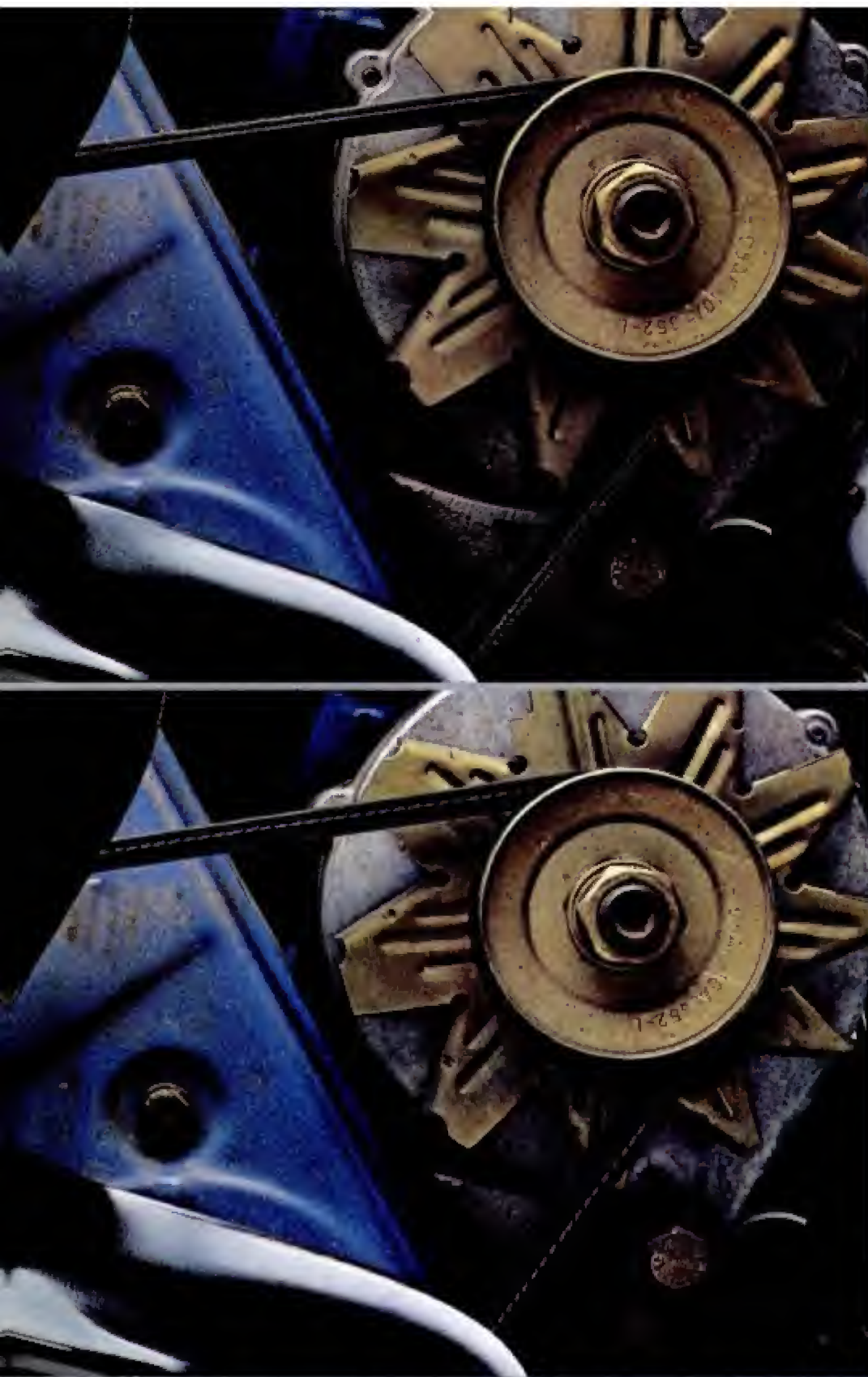
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## "MY ENGINE RAN WHEN IT WAS OFF

I'd switch the ignition off but the engine wouldn't stop. Instead it sputtered, rocked and coughed. Then I discovered WYNN'S® SPIT-FIRE. Now my troubles are over," writes a happy user. Yes, engine "after run" caused by heavy carbon build-up can be not only exasperating, but downright dangerous mechanically. So be kind to your car and yourself. Add a can of WYNN'S® SPIT-FIRE to your gas tank today. Sold at leading drug, auto parts and discount stores.





Chances are, you can't tell. Even though the top belt has put in 35,000 miles, while the other is just starting out.

The point is, most of today's belts simply don't show the obvious signs of wear you could once spot on fabric-wrapped belts.

A belt that looks okay can suddenly fail. And an engine running without a properly functioning cooling system can turn into scrap in a matter of minutes. Or at the very least leave you stranded.

So if you can't tell when a belt is about to go, what do you do?

Prevent disaster before it happens. Get in the habit of changing belts at least every two years or 24,000 miles, no matter how they look. It's an important part of the engine tune-up.

Just be sure that the new belts have our name on them. We've been producing top quality automotive rubber products for almost 70 years—and every one of them meets or exceeds new car specifications. So it's no wonder Gates belts and hoses are preferred the world over, demanded by more top mechanics and sold in more places than any other brand.

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## Which belt is about to ruin an engine?

**World leader in automotive belts and hoses.**  
The Gates Rubber Company, Denver, Colorado





# 14. Repairing electronic ignition (AMC, Chrysler)

**E**lectronic-ignition-system failure caused by a distributor malfunction can usually be repaired by the car owner. Mostly the failure results from a malfunction with the trigger wheel (reluctor) and/or the pickup assembly (sensor).

The following procedure outlines how to replace these parts in American Motors and Chrysler distributors. Ford and General Motors distributors are discussed on page 179.

### AMC distributor

**Note:** Four-cylinder 1980 AMC models use the GM high energy ignition (HEI) system. All other models use the AMC unit described below.

**1. Remove and examine the distributor cap.**

**2. Pull the rotor off the distributor shaft** and check for damage or wear.

**3. Remove the trigger wheel.** If a small gear puller is available, place a flat washer on the center of the distributor shaft and place the gear puller on the shaft so its jaws engage the underside of the trigger wheel. Tighten the gear puller to remove the wheel.

If you don't have a gear puller, hold two screwdrivers under the trigger wheel, one on each side, and lift the trigger wheel off the distributor shaft. Be sure to keep the trigger-wheel pin after removing the trigger wheel.

**4. Pry the retainer and washers from the pivot pin** on the distributor base plate. Unscrew the ground screw that secures the sensor assembly. Lift the entire sensor assembly out of the distributor.

**5. Remove the vacuum-advance unit** if it is damaged. To do this, remove the vacuum hose and unscrew the two screws holding the unit to the distributor body.

**6. Install the new vacuum-advance unit.** To calibrate it, insert an Allen wrench into the vacuum-hose ripple of the old vacuum unit and turn the screw clockwise, counting the turns until the screw tightens.

Now, tighten the adjusting screw of the new unit. Then, turn the screw of the new unit counterclockwise the same number of turns it took to tighten the screw in the old unit.

**7. Install the sensor assembly,** making sure the sensor pin engages the hole in the vacuum-advance-unit link. Secure the sensor to the base plate with washers and retainer.

**8. Place sensor-assembly wiring harness in slot** of the distributor housing. Install and tighten ground screw.

**9. Press the trigger wheel** by hand onto the distributor shaft until the groove in the wheel and the slot in the distributor shaft are aligned. Tap the trigger-wheel retaining pin into place.

**10. Install rotor and distributor cap,** and time the ignition.

### Chrysler distributor

Chrysler uses two types of distributors. One is a basic electronic distributor in six- and eight-cylinder models. The other is the Hall-effect distributor in most four-cylinder models.

To repair the basic electronic distributor:

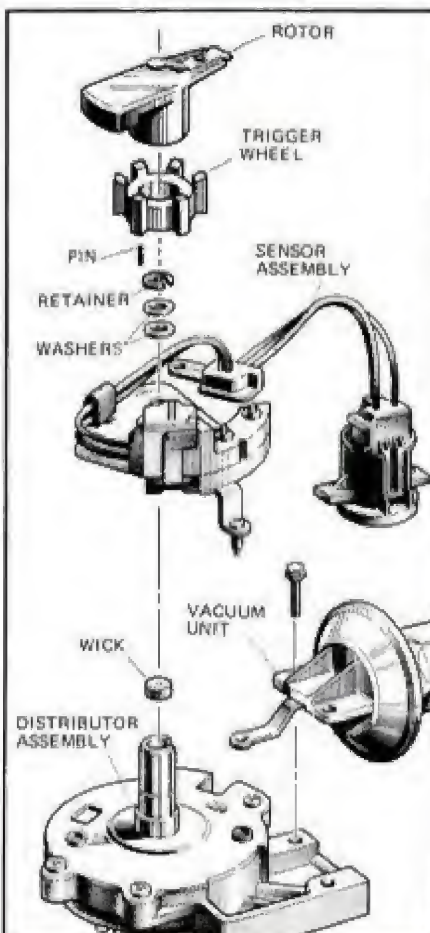
**1. Remove and examine the distributor cap.**

**2. Remove the rotor.** If it doesn't come off easily, place two screwdrivers under the upper rotor housing and pry the part off. Examine the rotor.

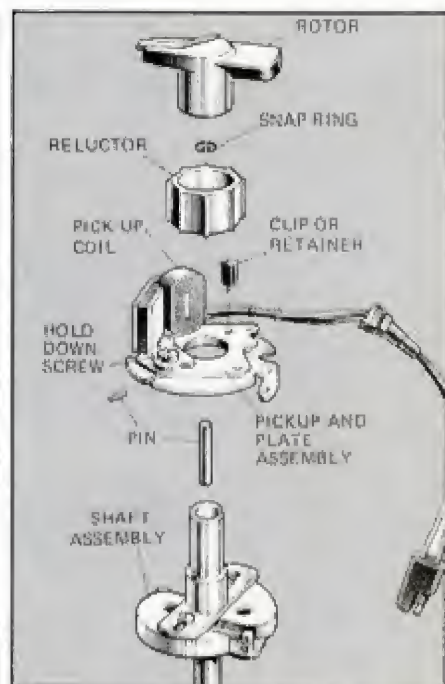
**3. Place two screwdrivers** (not to exceed  $\frac{7}{16}$  in. in width) under the reluctor and pry up. Avoid damaging the reluctor teeth.

**4. Remove the two screws and lock washers** that hold the pickup and plate assembly, and remove the assembly.

**5. Adjust the air gap between the**



The AMC distributor has a lubricating wick, which should be oiled periodically.



Air gap between the reluctor and the pickup coil must be set with a plastic gauge.

reluctor and pickup coil after the distributor has been reassembled.

Align a tooth of the reluctor with the tooth of the pickup coil. If the teeth aren't aligned, engage the large nut in the center of the crankshaft pulley and turn clockwise until the two are parallel.

Loosen the pickup-coil hold-down screw and insert a 0.008-in., nonmagnetic feeler gauge between the two teeth. The gauge must be nonmagnetic. Plastic is suitable.

Adjust the air gap until the three elements—reluctor tooth, pickup-coil tooth and feeler gauge—touch.

Tighten the hold-down screw and remove the feeler gauge. No force should be needed to get the feeler gauge out. Check the measurement by trying to fit a 0.010-in. feeler gauge between the two teeth. Do not force the gauge. If it does not slide into place easily, the adjustment is correct.

### Hall-effect distributor

To repair the Hall-effect distributor:

**1. Remove and examine the distributor cap.** It is held in place by two hold-down screws.

**2. Pull the rotor off the distributor.** Examine the rotor.

**3. Remove the screw and lock springs** and lift the Hall-effect pickup assembly out of the distributor.

**4. Reverse this procedure to reassemble the distributor.** **PM**



# CAR CARE MONTH

by **Peter Noznesky**, Chairman  
Automotive Parts & Accessories Association






















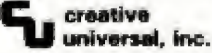





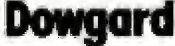






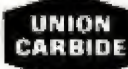



For the past several years, "May is Car Care Month" has been instrumental in showing automobile owners how to maintain their cars. It has provided helpful hints to achieve efficient operation, increase fuel mileage, and practical service tips.

"May is Car Care Month" has been co-sponsored by the Automotive Parts & Accessories Association and POPULAR MECHANICS for eight consecutive years. As a result of this program, tens of millions of car owners and drivers have learned the rewards of regular car care.

In addition, hundreds of cooperating newspapers throughout the nation participate in this program by scheduling special Car Care sections during the month of May.

Everyone who owns or drives a car can derive benefits from the Car Care Programs. They are designed with you in mind and have as objectives car safety, efficient performance and economy of operation.

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## One of these men drives himself to work, drives himself home and drives up his cost of living.

He doesn't see it that way. He's been driving himself to the office every day for several years now. He actually enjoys the ride.

Problem is, with today's energy crisis, the man on the right is wasting both fuel and money. Gas prices alone make the trip expensive. And his auto insurance premium is higher than it has to be.

The man on the left has decided to conserve and save. When the gasoline shortage began, he and some neighbors started carpooling to work. So together they consume less gas. That cuts expenses right there. What's more, because each of them drives fewer miles, they save money on their auto insurance as well.

As a major group of property and casualty insurance companies, we're doing our best to help you keep your insurance rates affordable. That's why most auto insurers are offering discounts to those individuals who reduce the total number of miles or times they drive to work.

For example, people who normally drive 30 miles to and from work every day can save up to 22% on car insurance premiums just by carpooling. All they have to do is drive to work two days a week instead of five.

People who switch to public transportation to get to work save even more on their premiums—up to 31% in some states. Their car becomes classified "for pleasure use only," a less expensive category.

### Here's what we're doing to control costs:

- Offering premium discounts to those who reduce the total number of miles they drive each week to work. Discounts will vary by company, by state and by the type of coverage you have.
- Cracking down on insurance fraud practices through the Insurance Crime Prevention Institute and the National Automobile Theft Bureau.
- Working through the Insurance Institute for Highway Safety to make cars and roads safer.
- Investigating injury and repair claims more thoroughly.

### Here's what you can do:

- Cut down on your driving by carpooling or by using public transportation.
- Use your auto seat belt and shoulder harness.
- Talk to your insurance agent or company about ways to lower the cost of your auto insurance coverage.
- Lock your car. Don't invite trouble.

## Affordable insurance is our business...and yours.

This message is presented by the **American Insurance Association**, 85 John Street, New York, New York 10038.



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by itself. All you do is load or unload, hitch or unhitch, get in and go. You get excellent height, ride, and control qualities all the way. This time get CarGo Coils instead of air shocks. Ask for them wherever your car is serviced or write us for information. It's eight-to-one you'll like them better.

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Missouri 63177





# 15. Repairing electronic ignition (Ford, General Motors)

**D**istributor parts that usually wear or become damaged are the armature, stator assembly and vacuum advance. If one must be replaced, be certain to follow this procedure:

### Ford distributor

1. Remove the distributor cap.
2. Pull rotor off the distributor shaft.
3. Remove the adapter—the top part of the distributor housing that possesses the cap hold-down clips.
4. Disconnect the distributor wiring-harness plug.
5. Remove the armature. Hold two screwdrivers under the armature wheel, one on each side, and lift the armature off the distributor shaft. Be sure to keep the armature roll pin.
6. Pry the large wire-retaining clip from the armature groove in the distributor shaft. Unscrew the ground screw holding ground strap to the base plate.
7. Grab the pickup coil wiring harness outside of distributor housing and pull it up to remove it from its slot.
8. Remove the E-clip that holds the vacuum-advance unit link to the stator assembly. Lift the link off the post of the stator assembly and slide it aside. This releases the stator assembly, which can now be removed from the distributor.
9. Undo screws and identification tag; then slip the vacuum-advance unit off the distributor.
10. Replace the vacuum-advance unit, making certain to get the correct one for your distributor. Instructions that come with the vacuum advance show how to calibrate the unit.
11. Assemble all the components in reverse order of disassembly.
12. Time the ignition system. There are no other adjustments that are necessary to make.

### General Motors distributor

The General Motors High Energy Ignition (HEI) system distributor is unique in that all electronic components of the ignition system are housed in the distributor. To remove the integral ignition coil inside the distributor cap of all GM cars with electronic ignition (except those with 140-cu.-in., L-4 engines), proceed as follows:

1. Lift the two retaining tabs of the wire-harness connector and remove the connector from the distributor cap.
2. Remove the three coil-cover attaching screws and lift off the cover. The coil cover is located on top of the distributor cap.
3. Unscrew the four coil-attach-

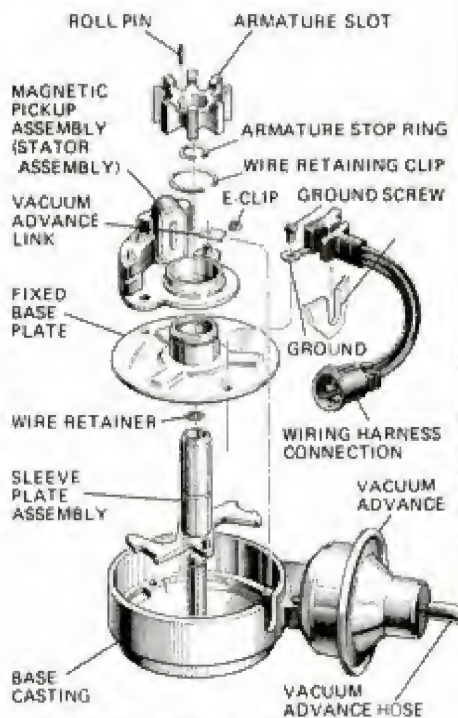
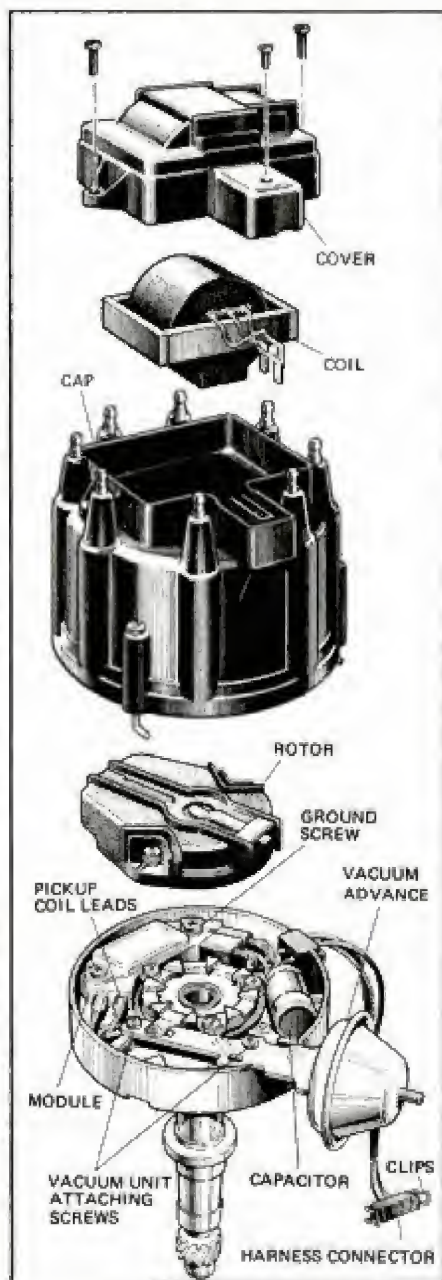
ing screws and remove the integral ignition coil.

4. Take out the coil arc seal. It is in the top of the cover. Replace this seal when you replace the coil.

5. To install a new coil, reverse this procedure.

### Control module

To replace the electronic control module, proceed as follows:



The difference between the Ford electronic ignition system (above) and the General Motors system (left) is that the GM unit houses all ignition components within the distributor body. The operating principle of both, however, is the same.

1. Remove and examine the distributor cap.
2. Undo the two screws holding the rotor in the distributor. Notice that the rotor has a slot that fits over a square lug on the advance weight base. This assures that the rotor can only be installed one way.
3. Disconnect the two pickup leads from the module. Take note of the two color-coded leads. They must be reinstalled correctly.
4. Undo the two screws holding the module in the distributor, remove the module and then pull off the two wire connectors.

### Removing the capacitor

To remove the capacitor properly, do the following:

1. Remove the distributor cap and rotor.
2. Undo the screw holding the capacitor. Then unplug and remove the capacitor.
3. Install the new capacitor and reinstall the screw that holds the unit in place, making sure the ground wire is under it.

FM



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- ☐ who drive in stop-and-go traffic.
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- ☐ who drive in hot climate.
- ☐ who drive on ice or snow covered roads.
- ☐ who drive a RV or pull a trailer.

Over 10,380,000\* transmissions failed last year. Nine out of ten failures were caused by overheating. Had these motorists known about transmission oil cooling protection, they would have saved \$400 to \$600 on repairs.

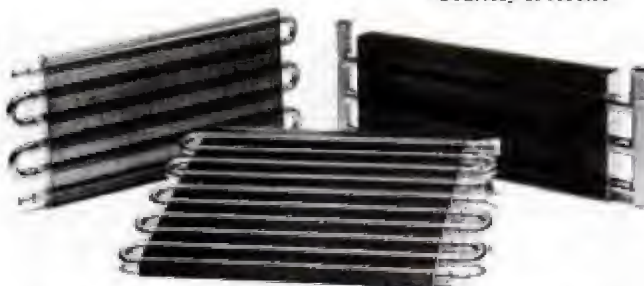
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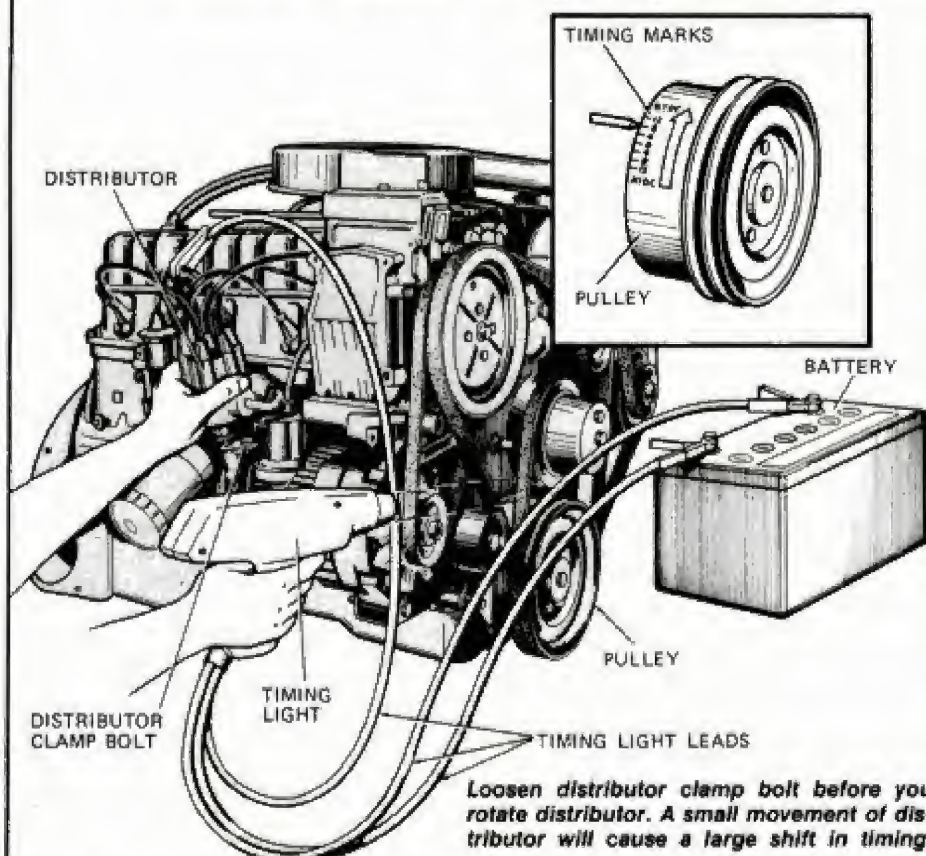


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# 16. Timing ignition system



Loosen distributor clamp bolt before you rotate distributor. A small movement of distributor will cause a large shift in timing.

Ignition timing refers to the instant the sparkplug ignites the fuel mixture in relation to the position of the piston in the cylinder. From the standpoint of engine performance, it is one of the most important adjustments you can make. If ignition timing is too far advanced, causing ignition to take place too soon before the piston reaches top dead center (TDC), pistons and valves are put under unnecessary stress that may damage them.

If ignition timing is retarded excessively, causing ignition to occur too late, engine power is lost and there is an increase in fuel consumption and exhaust emissions.

To set timing properly, you need to know the timing specification for your engine. This is printed on the emissions information label mounted in the engine compartment, in the service manual for the car, and, in some cases, in the owner's manual.

**1. Warm up the engine** and make sure the carburetor's idling speed is adjusted to specification.

**2. Turn off the engine** and connect the timing light. Usually, the pickup lead of the light is connected to the No. 1 sparkplug by inserting an adapter cable between the plug and the plug cable. An adapter is needed to avoid piercing, and ruining, the sparkplug cable with a current-pickup device.

However, if the timing light possesses an inductive magnetic pickup, you can connect the pickup directly to the cable of the No. 1 sparkplug without fear that you might pierce the cable.

**3. Locate the timing marks** on the crankshaft pulley, vibration dampener or timing-gear case cover, or at the rear of the engine on the flywheel. Wipe marks clean. If they don't stand out enough, rub white chalk or dab white paint on the specified timing mark for your engine and also on the index pointer or line.

**4. Start the engine.** Be careful during the entire procedure. You will be working near moving belts, pulleys and the fan.

**5. Disconnect and plug the vacuum hose** from the vacuum-advance unit if this is called for on your car. Use a golf tee or pencil stub as a plug to prevent loss of vacuum.

With some models, it is necessary to leave the vacuum hose connected. Most notable of these are Datsun, except 1970 models with R and U20 engines, 1979 model 210 FU, 1980 model 510 and 1980 models built for sale in all states except California; Honda, except 1973 and 1974 models; Toyota; and Volkswagen, except models prior to 1971, and 1973 and 1974 models that have one vacuum hose attached to the distributor.

**6. Aim the timing light** at the timing mark. Hold the instrument as you would a pistol. Don't tilt it; sight straight down the tool. If the ignition is timed to specification, the specified timing mark will appear stationary in relation to the pointer or index mark. If the timing mark wavers each time the timing light emits a beam, the timing will have to be adjusted.

**7. Loosen the distributor hold-down bolt** to adjust timing. This frees the distributor so that it can be rotated. You will have to use an offset wrench if you have trouble reaching the hold-down with a conventional wrench.

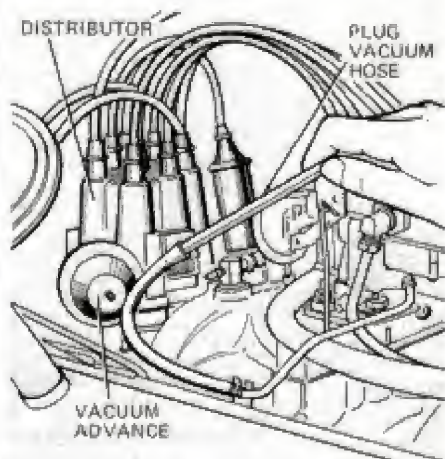
**8. Slowly turn the distributor** as you aim the timing light at the timing mark. If the timing light starts wavering worse than it did before, turn the distributor in the opposite direction. Keep turning until the specified timing mark lines itself up with the pointer or index mark and appears frozen in place each time the light flashes.

**9. Tighten the distributor hold-down bolt**, or bolts, and recheck the setting to make sure timing wasn't upset as the distributor was being tightened.

When checking timing, also check the vacuum-advance unit. This is easy to do, since the timing light is already connected.

**10. Remove the plug** from the vacuum-advance hose and reattach the hose to the vacuum-advance unit. As an assistant in the car presses the accelerator pedal gradually to increase engine speed, pull and push the vacuum-advance hose off and on the vacuum-advance unit as you aim the timing light at the specified mark. This should cause the timing mark to shift rapidly.

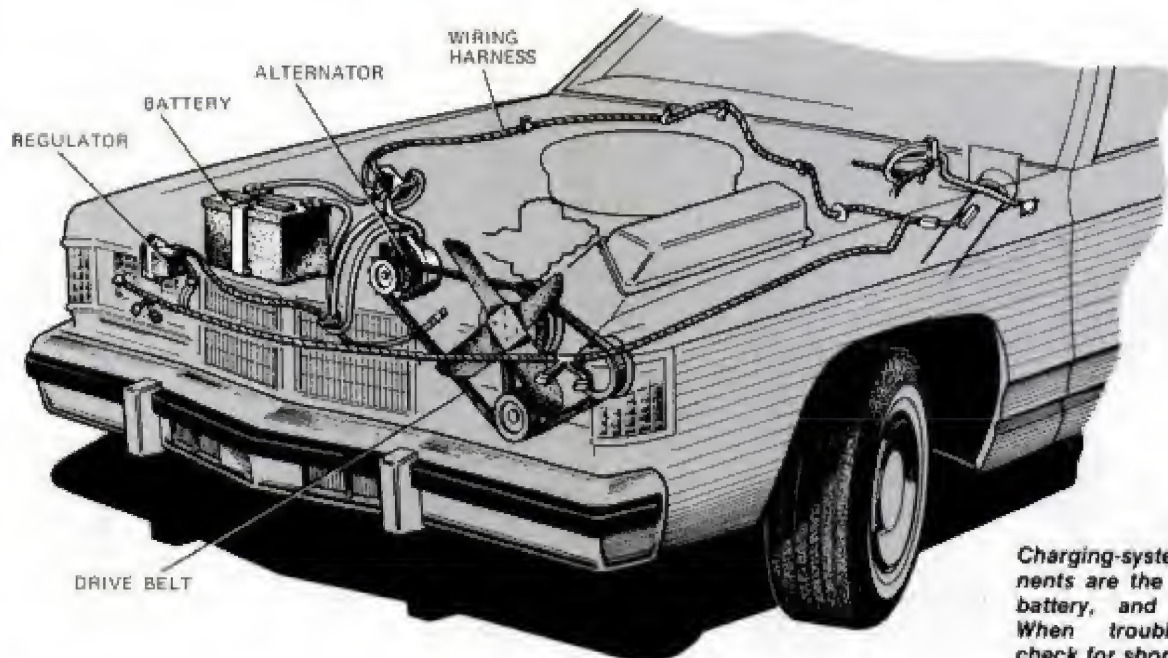
If the mark doesn't move or moves sluggishly, the vacuum-advance diaphragm has probably ruptured and is leaking. Replace the vacuum-advance unit. **PM**



Remove and plug vacuum-advance hose. To check hose blockage, feel for suction.



# 17. Testing charging system



Charging-system components are the alternator, battery, and regulator. When troubleshooting, check for short circuits.

**T**he charging system consists of the alternator, regulator and battery. The alternator provides electricity that charges the battery and operates electrical components.

The regulator adjusts alternator output to the demand placed on the alternator by electric components. It prevents excessive electric output, which damages components.

In the illustration above, the regulator and alternator are pictured separate from each other. In some cars, they are. In others, the two are integrated, with the regulator housed in the alternator.

A charging-system problem makes itself apparent in one of the following ways:

■ **No charge.** With the engine running, the charging-system light glows, or the ammeter

registers zero or shows a slight discharge.

■ **Discharge.** With the engine running, the charging-system indicator light glows, or the ammeter shows a significant discharge.

■ **Undercharged battery.** With the engine running, the charging-system indicator light may glow dimly, or the ammeter may show a slight discharge when accessories are on. Headlights will be dim.

■ **Overcharged battery.** With the engine running, the ammeter will show a high charge, even with all lights and accessories on. The battery will need water often, and headlights will be very bright. Bulbs and fuses may burn out frequently.

### Testing alternator, regulator

**1. Connect a voltmeter to the battery** and make note of battery voltage with the engine off. If voltage is less than 9.6 volts, charge battery and take another reading.

**2. Start and run the engine** at 1500 to 2000 rpm. Record the voltage reading. The reading with the engine running should be two or more volts higher than battery voltage without the engine running. If it is, the alternator is probably okay. If voltage is not higher, see the servicing procedure below.

To check the regulator, continue to run the engine at 1500 to 2000 rpm until the voltmeter records the highest reading it will reach. If the voltmeter needle continues to climb, the regulator is faulty and should be replaced.

### Servicing procedure

**1. Check the alternator drive belt for damage.**

**2. Test the alternator drive belt for proper adjustment.** A loose belt may be the cause of battery discharge. A belt too

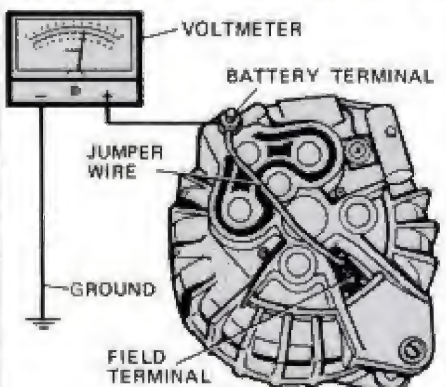
tight causes stress to alternator bearings.

**3. Inspect all connections at the alternator, regulator and battery** for tightness and cleanliness. Clean corrosion from terminals and see that wires aren't cracked or frayed. Replace damaged wires, which could ground against metal and short the charging system.

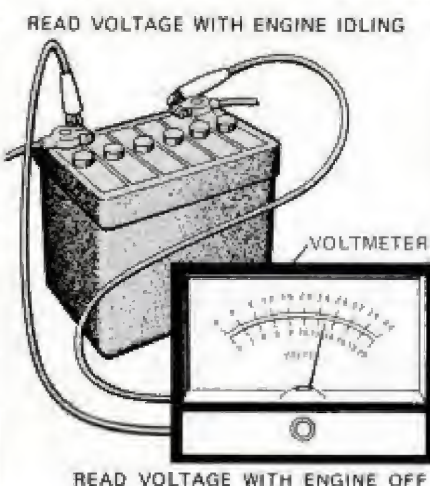
**4. If the cause of the low-voltage reading** hasn't been found, the alternator should be replaced or overhauled.

To make sure, test the alternator for output. This is done by hooking up a voltmeter and disconnecting the alternator field terminal as the engine is run at fast idle. If the voltmeter doesn't read between 14 volts and 15.5 volts, the alternator should be removed from the car for servicing.

**Caution:** Alternator output should not exceed 15.5 volts during test to prevent damaging an otherwise functional alternator. **FM**



To test alternator output, connect voltmeter and run engine at 1500 to 2000 rpm.



Voltage reading with the engine running must be higher than when engine is off.



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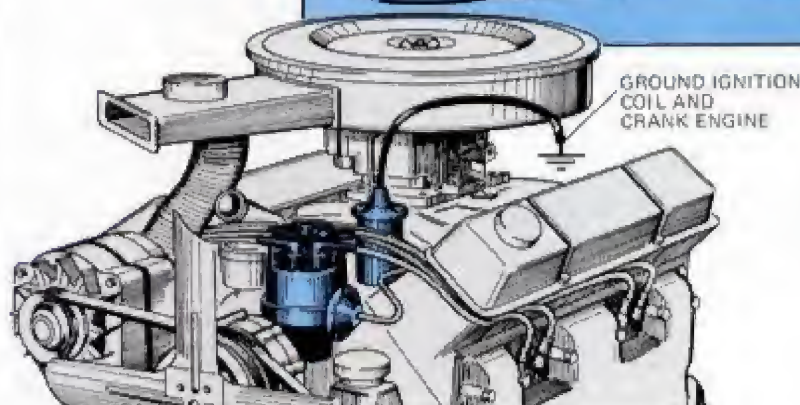
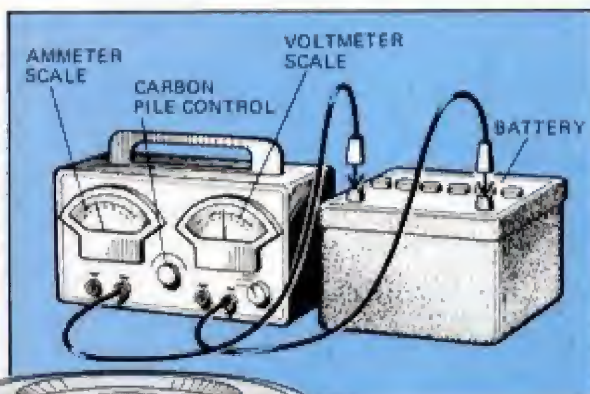
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# 18. Testing battery condition

To test the battery with a conventional voltmeter, ground the ignition coil, hook up meter and crank engine for 15 seconds. Or use a meter with carbon pile which imposes a load similar to that of the engine and which doesn't require any cranking.



### Voltmeter test procedure

**1. Ground the ignition circuit** by removing the coil-to-distributor high-tension cable at either the coil or distributor.

**2. Attach one end of a jumper wire** to the cable terminal and the other end to a metal part of the engine.

**3. Crank the engine** for 15 seconds as you watch the voltmeter.

If voltage after 15 seconds is 9.6 volts or more, the battery condition is adequate. If the voltmeter reads less than 9.6 volts after the engine is cranked 15 seconds, charge the battery and retest it. If voltage does not increase to 9.6 or more, you should plan to replace the battery.

Some voltmeters have a carbon-pile resistance that allows imposition of a load on the battery without the need to crank the engine. To use this instrument, connect the tester across the battery terminals and turn the carbon-pile control knob so a load is imposed equal to three times the battery ampere-hour rating. This rating should be stamped on the battery.

Read the voltmeter after 15 seconds to see if you get a reading of 9.6 volts or more. If not, charge the battery. Then retest it. If voltage does not increase to 9.6 volts or more, the battery is in poor condition. **FM**

If you have a maintenance-free battery, you may not be able to use the hydrometer or cell tester, since some of these batteries are designed with nonremovable cell caps or covers. You will have to use a voltmeter.

### Hydrometer test

**Important:** Don't test the battery just after water has been added. If the electrolyte level in cells is low, add water and drive the car several miles before doing the hydrometer test.

**1. Disconnect the battery ground cable.** In most vehicles, this is the negative cable.

**2. Remove cell caps.**

**3. If your hydrometer has a temperature scale,** draw samples of electrolyte into it from three or four cells, noting the temperature each time. Be sure to return the electrolyte to the cell from which it was taken.

The ideal temperature is 80°F. For every 5° above 80°, add two (.002) points to the specific gravity reading. This correction compensates for the loss of specific gravity caused by the expansion of the electrolyte as temperature increases.

For every 5° below 80°, subtract two (.002) points to compensate for the gain in specific gravity that the contraction of the solution causes as its temperature decreases. Many temperature compensating hydrometers have these figures on a scale.

**4. If your hydrometer doesn't have a temperature scale,** insert a thermometer in

the electrolyte and record temperature. Use the formula above to make the temperature corrections.

**5. Take samples from each cell** and record the specific gravity. Return each sample to its respective cell. When you are done, make temperature corrections as explained above, if necessary.

### Interpreting readings

An average specific gravity of 1.240 to 1.270 indicates that the battery is sound. If the average reading is less than this, charge the battery and test again. If a battery needs frequent charging, the electrical system should be inspected for a possible malfunction.

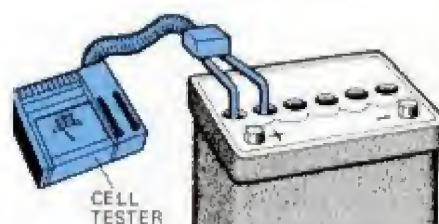
### Using the cell tester

The cell tester checks voltage in each cell and differences in voltage between cells. It'll tell you if your battery has a dead cell.

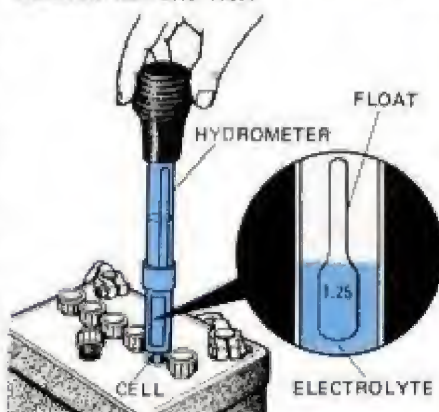
To use the tester, remove all cell caps. Insert the tips of the instrument into the electrolyte of two adjacent cells, and observe the meter. Do this for all cells, then compare the readings.

The band on the instrument will tell you the condition of the battery. For example, if all readings fall in a green band, it means the battery is okay. If all readings fall in the red band, it means the battery should be charged and retested. If the test doesn't show an improvement in battery condition after charging, replace the battery.

TAKE FIVE READINGS  
BY CELL PAIRS

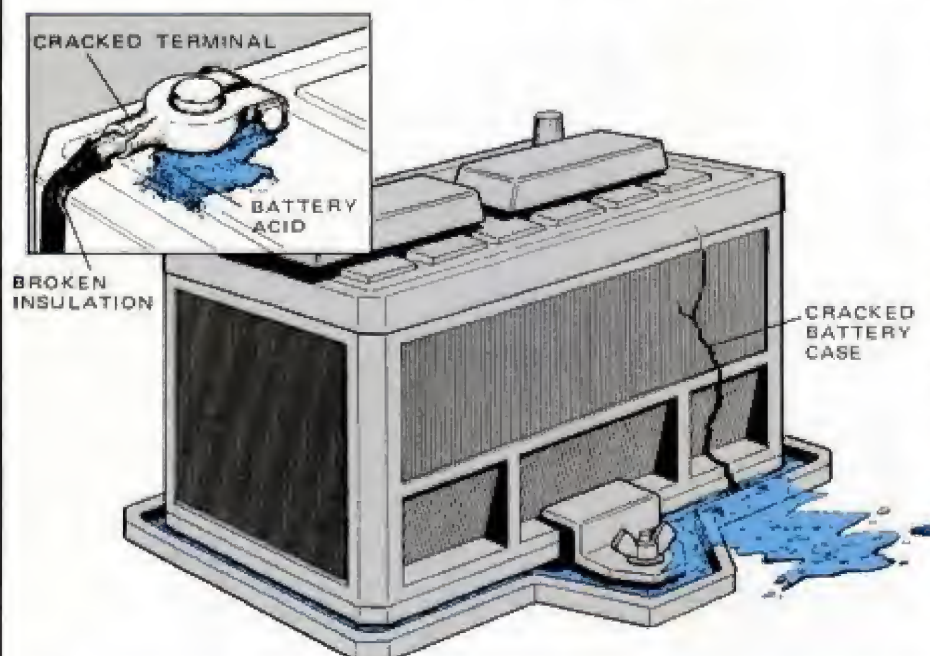


Cell tester measures voltage of each cell. The hydrometer test (below) logs the specific gravity of electrolyte. Ideal reading is between 1.24 and 1.27.





# 19. Servicing the battery



**S**ervicing a battery entails the replacing of damaged components, keeping the battery clean, servicing battery cables and keeping battery electrolyte up to level.

### Inspecting the battery

■ **Battery cables.** Look for gray or black corrosive deposits around the terminals and battery posts. Deposits insulate the cable from the post, block current flow and cause engine starting problems.

If a loose cable terminal can't be tightened, replace it. Look for frayed cable insulation, especially at terminals. Replace a cable which has exposed wires.

Check tightness of the battery ground cable at the ground spot and the battery "hot" cable at the starter relay or starter terminal. The metal area to which the ground cable is attached should be clean.

■ **Battery case.** Disconnect cables and remove the battery from the car, using a battery-carrying tool. Don't move a battery by

hand. There's a chance you may lose your grip and drop it.

Check the battery case thoroughly for cracks. Replace a cracked battery.

■ **Battery box.** The box, or carrier, on which the battery sits is often disregarded. If it is loose, it can cause the battery to vibrate and be damaged, so make sure bolts and nuts are tight. If there is corrosion or rust, scrape it off with a wire brush and coat it with a durable enamel paint.

### Cleaning the battery

If there is no corrosion on the battery, washing it with plain water every so often is enough. If corrosion and residue are present, a more thorough cleaning with baking soda will help prolong battery life. Corrosion on the battery acts as a conductor to drain the battery.

**1. Take the battery out of the car** and place it on the ground. Cover cell caps with tape to prevent the baking soda from getting into the cells. Make sure all caps are tight.

**2. Using a stiff bristle brush, wash the battery** with a solution of baking soda and warm water, mixed 1:1. Then wash the battery with clean water and repeat the procedure.

**3. Clean battery posts** with the post end part of a battery-cleaning tool. This tool possesses a wire brush that does a good job of removing corrosion and dirt.

**4. Let the battery dry.** Remove tape from cell caps and put the battery back into the car. Before connecting battery cables, use the cable terminal cleaning end of the tool.

Avoid using sandpaper or a penknife to clean battery posts and cable terminals. They will whittle down the battery posts and enlarge cable terminals. A battery cleaning tool does the best job.

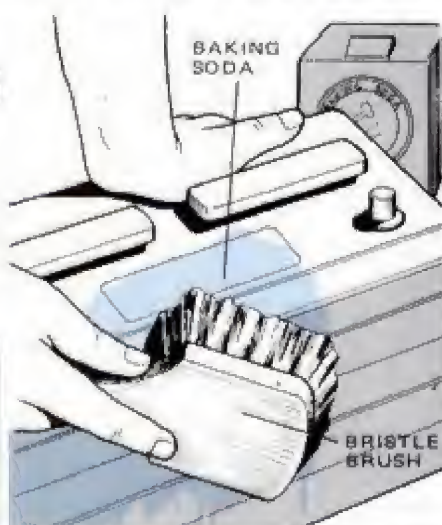
### Maintaining electrolyte level

Check electrolyte level frequently. When the level is low, fill cells with distilled or clean tap water to the ring in the bottom of the filler hole.

A battery that needs water often is one that may be receiving too much charge from the alternator. Check by testing the charging system.

### That mysterious eye

Many maintenance-free batteries have a state-of-charge indicator, which has caused some confusion. This indicator does not tell you if the battery is good or bad; it indicates whether the battery should be charged before being tested. For example, the indicator of a Delco Freedom battery spells out one of



**Washing a battery with baking soda will neutralize the acid that forms on case.**

the following conditions:

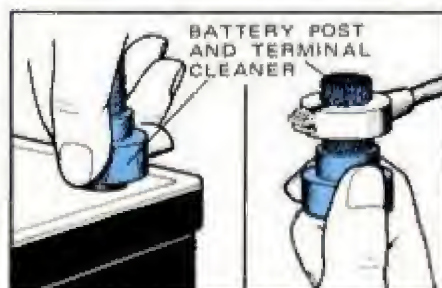
■ If the border of the indicator is dark and there is a green dot in the center, the battery is sufficiently charged, and the battery can be tested.

■ If the indicator is dark throughout, charge the battery before testing. When the battery has charged properly, the green dot will appear.

■ If the dot is light, don't charge the battery. It has developed a high concentration of internal gas, which will be aggravated by charging.

If there is no cranking problem evident, continue using the battery until it fails. Then replace it.

FM



**Special tool provides the best way to clean the battery posts and cable terminals.**



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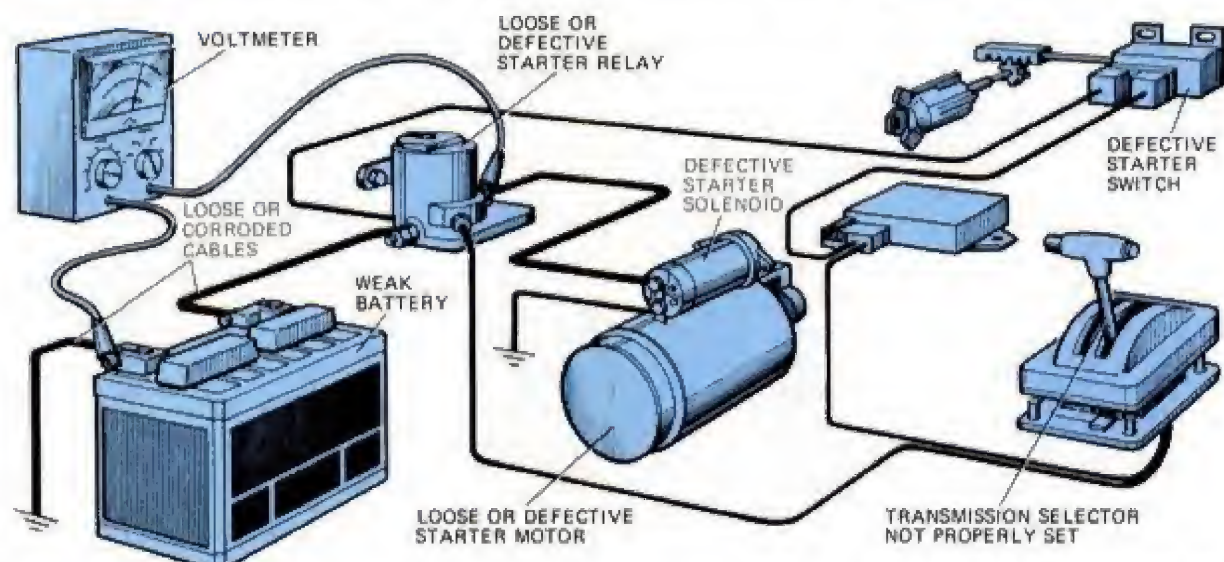
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# 20. Testing starting system



**T**here are variations in starting systems from one car to another. Many use starter relays. Some don't. Some have a solenoid on the starter motor. Others don't.

Differences notwithstanding, every starting system works the same. When it's activated, current from the battery is delivered to the starter motor, allowing the starter-motor pinion drive gear to engage the engine flywheel. The starter-motor armature rotates, driving the drive gear and flywheel. This causes the engine crankshaft and all attached components to rotate. After the engine starts, the pinion drive gear disengages from the flywheel, and the starter shuts off.

### Inspecting the system

A starter motor may act sluggish in the early stages of a problem. As the problem gets

worse, the starter motor won't be activated at all; then your car won't start. Often the cause of the trouble is something minor that can be found by visually inspecting the starting system. After making sure that the battery is charged and the battery cables are clean and tight, look for:

- A securely mounted starter relay, with clean, tight cables.
- A starter cable that is free of corrosion and securely connected to the starter motor (or solenoid) and to the starter relay (or the battery).
- A starter motor that is securely mounted.
- A transmission selector that is firmly engaged in PARK or NEUTRAL. Most vehicles have a safety switch that prevents starting when the transmission is in gear.

If all these areas check out, testing of the starting system's components then becomes necessary.

### Testing the starter relay

Some cars have a starter relay between the battery and starter motor that controls the heavy electric current sent to the starter motor. The starter relay possesses a set of contacts that close when the ignition switch is turned on to allow current to reach the starter motor.

To check the starter relay, connect a voltmeter to the starter-cable terminal of the relay and to the negative post of the battery. Turn the ignition key to START position.

You should hear the starter relay click and the voltmeter should record battery voltage, less approximately  $\frac{1}{2}$  volt caused by circuit resistance. If there is clicking, but the voltmeter shows no or low voltage, replace the relay.

If the relay doesn't click, disconnect the voltmeter and ground the ignition system by removing the ignition coil-to-distributor cable

*These are the most common causes of starting malfunction. Begin by inspecting battery; then examine all connections.*

at the coil. Connect a jumper wire to the cable terminal and to a ground. This is a precautionary measure to assure that the car engine won't start while you are probing the terminals.

Turn the ignition key to START. Then disconnect the cable from the starter-relay "S" terminal, and connect a jumper cable to the battery's positive post. Touch the other end of the jumper to the relay "S" terminal. Depending upon the response, take one of the following actions:

**1. If the starter relay clicks,** there is a failure in the circuit from the starter switch to the relay. The failure may be with the starter switch, transmission neutral safety switch or wiring.

**2. If the starter relay does not click,** replace it.

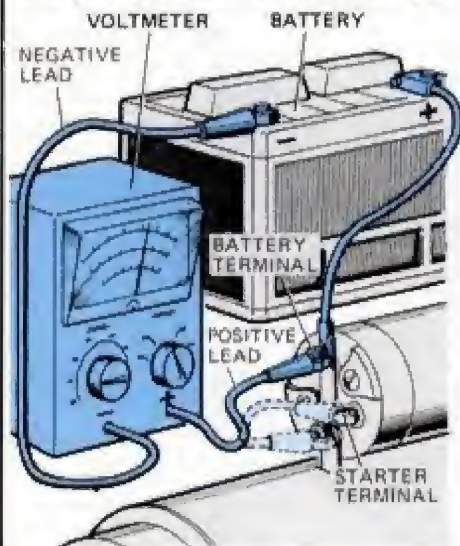
**3. If the starter relay clicks, but the starter motor does not operate,** the problem lies inside the starter motor (if the starter is not equipped with a solenoid). Remove the starter motor for testing on the bench.

If the starter is equipped with a solenoid, connect a voltmeter to the battery's negative post and turn the ignition key to START. Check voltage at the starter terminal, battery terminal and battery-cable terminal of the solenoid.

If the voltage reading remains practically the same as battery voltage when you probe the starter terminal, the trouble is inside the starter motor, which should be removed for testing.

If the voltage reading should zoom more when probing one terminal than the others, the trouble lies with the starter solenoid, which should be replaced.

PM



**Check the voltage at the three locations on the starter solenoid with a voltmeter.**





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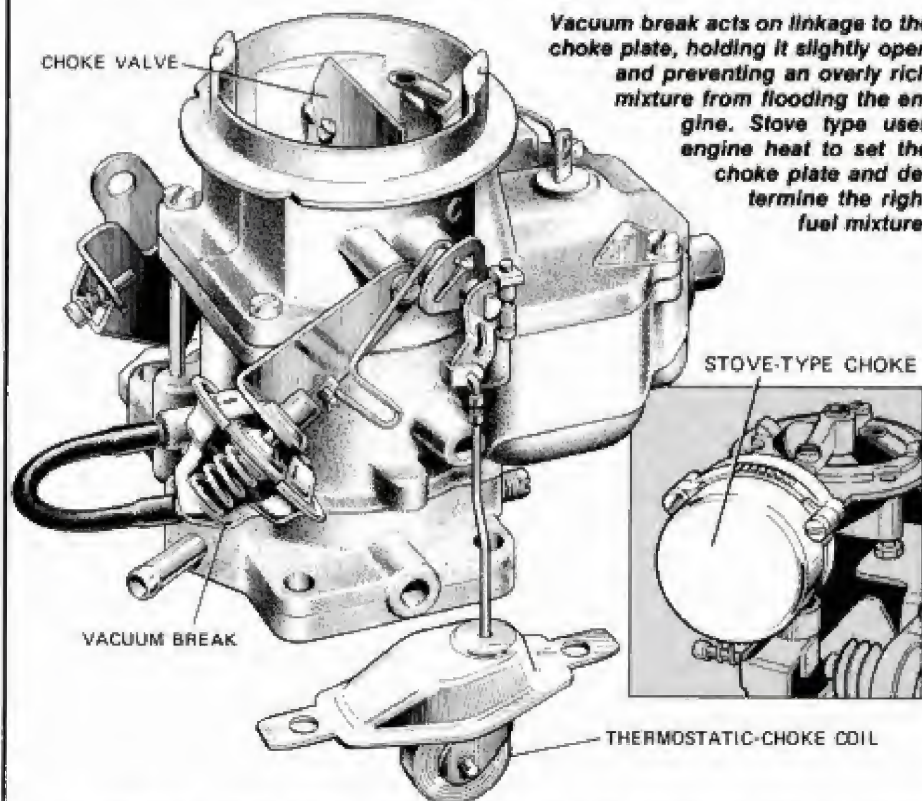
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# 21. Servicing automatic choke



**T**he automatic choke system closes a plate over the throat of the carburetor when a cold engine is started. It also activates the carburetor fast-idle system to keep the engine running at a higher than normal idling speed until it gets warm.

The choke system allows a richer mixture of fuel to enter the cylinders for quick starts. The combination of a richer fuel mixture and fast idle keeps the cold engine from hesitating and stalling during the first few minutes. As soon as the engine is warm and can run efficiently without a richer fuel mixture and faster idle, the choke system should shut down, and the fast-idle system should be disengaged.

The choke is set at the factory when the car is built. Generally, this setting will suffice for the life of the car, but in order to keep the choke operating properly, perform the cleaning service outlined below. If the engine hesitates or stalls, or becomes hard to start, troubleshoot the choke system as explained.

### Cleaning the choke

Clean the plate and linkage with carburetor cleaner once a year. Dirt produced by gasoline fumes and oil can accumulate at choke-plate pivots or on the linkage, causing the plate to stick open or closed.

If the plate sticks open, the fuel mixture will be too lean and prevent cold engine starting. It will also cause hesitation and/or stalling.

If the plate sticks closed, the engine will

receive a rich fuel mixture. This, too, causes stalling.

Remove the carburetor air cleaner and spray carburetor cleaner on the choke plate and pivot points. Spray the linkage that activates the choke plate. Wipe parts clean with a dry cloth. Do not oil choke-system parts.

### Inspecting the choke

With the engine cold, have someone start the engine. The choke plate should be closed over the carburetor throat.

When the engine starts, the choke plate should open slightly, but noticeably. As the engine warms up, the choke plate should open wider and wider as heat causes the thermostat spring that controls the choke to relax its grip, until the plate is fully open. If the choke doesn't operate in this manner, the choke-control unit may have to be removed from the car to replace the thermostat spring or, if so equipped, the choke piston. Before doing this, several external components should be checked. They are the heat tube, vacuum break and electric assist unit. Not every carburetor has all of them.

### Checking the heat tube

Choke systems with the control unit mounted on the carburetor (stove chokes) have a tube running from the engine to the choke control on the carburetor. If this tube cracks or comes loose, dirt drawn into the control can contaminate the thermostat.

Check the heat tube. If it is damaged, get a replacement.

Take off the choke control-unit cover and remove the thermostat spring. Clean out the housing and clean the spring in solvent.

### Examining vacuum break

Generally, stove chokes have a piston or a vacuum break that opens the choke plate when the engine starts. All other types of automatic chokes have one or two vacuum breaks on the carburetor.

A vacuum break has a diaphragm inside the housing which is activated by vacuum as soon as the engine starts. The diaphragm moves a linkage, which opens the plate enough to prevent stalling by a too-rich fuel mixture.

If the choke plate doesn't open when the engine starts, disconnect the vacuum hose from the vacuum break. With the engine running, hold your thumb over the hose. If suction is weak, replace the hose. Also, clean out the port at the base of the carburetor where the hose connects.

To determine if the diaphragm in the vacuum break is in good condition, attach a clean hose to the vacuum-break hose fitting and suck in on the other end. If the linkage that connects to the choke plate doesn't move, replace the vacuum break. If the linkage moves, press it into the vacuum break and hold your thumb tightly over the end of the hose. Release the linkage. If it moves with the hose plugged, replace the vacuum break.

### Checking the electric-assist

Some chokes have an electrically heated element that causes the choke plate to open as quickly as possible. This reduces exhaust emissions caused by rich fuel.

To check the function of the electric-assist, start the engine (cold) and pull the wire off the electric-assist unit on the choke control. Touch the wire to the contact. If there is no spark, trace the wire for shorts. If wiring is sound, replace the unit. **PM**



To test the diaphragm, apply vacuum to break and check for linkage movement.



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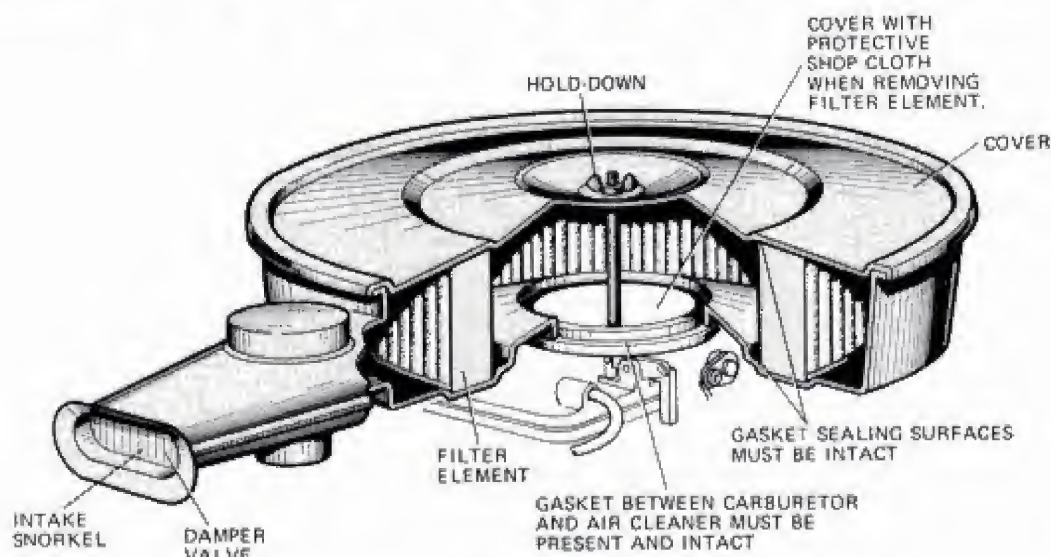
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# 22. Servicing air cleaner



The character of the carburetor air cleaner changed with the advent of exhaust emissions controls. The component is no longer used only to hold a filtering element. Now called the thermostatically controlled air cleaner, it also is used to preheat air entering the carburetor when the engine is cold.

By using the air cleaner as a preheater, manufacturers can calibrate carburetors to lean settings, which help reduce hydrocarbon emissions. Furthermore, preheating air entering the carburetor when the engine is cold improves engine warm-up characteristics and helps prevent carburetor icing.

A malfunction of the various elements of the thermostatically controlled air cleaner can cause engine performance problems, including stalling, rough idling, lack of power and increased fuel consumption. It is, therefore, wise to check the condition of the air cleaner periodically.

### Disassembling air cleaner

You may have to disassemble the air cleaner to replace a defective part. To do this, proceed as follows:

1. **Remove the wingnut, or hold-down nuts, holding the air cleaner to the carburetor.**
2. **Remove the cover** and take out the filtering element for inspection.
3. **Disconnect hoses.** As you do, tag each with a piece of masking tape so you'll be able to reattach the hoses to their proper points.
4. **Remove the air cleaner** by detaching the fresh air duct from the snorkel, if there is a duct.

**Important:** There is usually a gasket between the carburetor and air cleaner. Inspect this gasket. If it is damaged, replace it. It is important to reinstall this gasket, so dirt can't be drawn into the carburetor from around the base of the air cleaner.

### Inspect filtering element

Remove the air-cleaner cover and place a clean cloth around the carburetor throat to prevent dirt from dropping into the carburetor. Lift the filtering element from the air-cleaner housing.

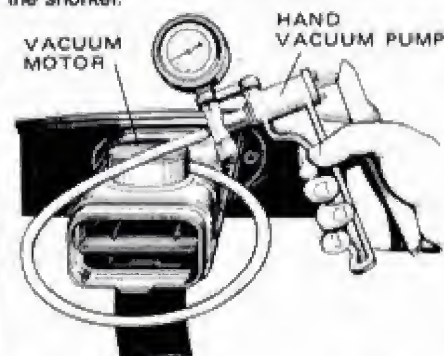
Slam one of the flat, solid endpieces of the filtering element against a hard surface to remove surface dirt. Then hold a droplight against the inner surface of the element. If you can see light through the filter and there are no holes or tears in the element, keep the filter. However, if the filter is blocked by dirt, torn or wet with oil, replace it. Before installing the element, wipe inside of the housing.

You may notice another filtering element in the housing—a smaller element, on one side, to which a hose is connected through a hole in the housing. This is the PCV filtering element. It must be replaced periodically.

### Testing the components

Do the following test when the engine is cold:

1. **Remove the fresh air duct** from the snorkel.



Apply vacuum to the vacuum motor to check for damper operation. If you have no hand pump, draw air with your mouth.

2. **Look inside the snorkel** as someone starts the engine. The damper valve in the snorkel should be closed. If it isn't, there is a malfunction which should be traced.

3. **Hold a thermometer against the valve** if it is closed.

4. **Read the temperature scale,** which should be between 105°F. and 125°F. as soon as the valve starts to open. If temperature is not within this range, replace the sensor in the air-cleaner housing. The damper valve should swing wide open as the engine reaches operating temperature.

### Valve doesn't close

If the damper valve doesn't close when a cold engine is started, and you have a hand vacuum pump, disconnect the vacuum hose at the vacuum motor on the air-cleaner snorkel. Attach the vacuum pump and apply vacuum as the operating handbook describes.

If the damper valve in the snorkel still doesn't close, replace the vacuum motor. If the valve does close, its malfunctioning is due to a torn vacuum hose, damaged damper valve linkage or loss of engine vacuum.

If you don't have a hand vacuum pump, disconnect the vacuum hose at the end opposite the vacuum motor—that is, at the vacuum source. Inspect the hose for damage; then create suction with your mouth. If the damper valve doesn't move, the vacuum motor is probably damaged.

### Replacing the sensor

1. **Remove the air cleaner** from the carburetor.
2. **Find the sensor** in the air-cleaner housing.
3. **Pry up on the tabs** on the sensor-retaining clip.
4. **Remove and discard the sensor and gasket,** and replace them. **PM**





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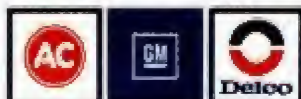
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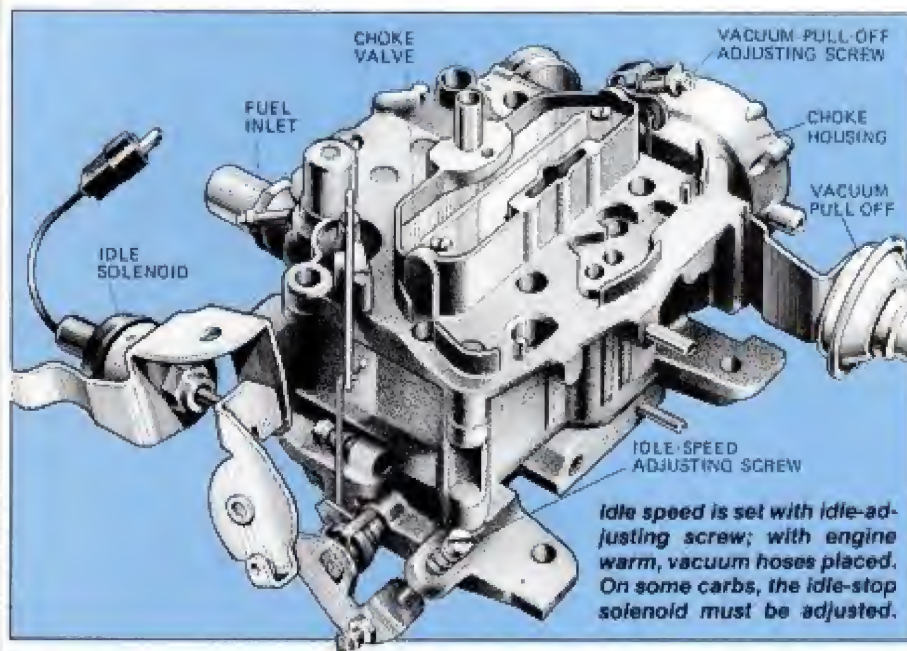


**Castrol**

The oil engineered for smaller cars.



# 23. Adjusting carburetor



**C**arburetors vary significantly in makeup and the adjustments they require. Generally, adjustments that can be made are slow-idling speed (also called curb-idling speed and hot-idling speed), fast-idling speed (also called cold-idling speed), idle mixture and dashpot.

Carburetors on some 1979- and 1980-model vehicles are nonadjustable. Check service literature to see if your car has one.

### Adjusting slow-idling speed

**Note:** Manufacturers set various conditions for setting slow-idling speed. Some want it set with the transmission in gear; others set with the trans in neutral. Some want the air conditioner turned on; others want it off. Check the emissions information label in the engine compartment or service manual for instructions. The information label and service manual will also specify your slow-idling speed. Adjust as follows:

1. **Warm up the engine.**
2. **Connect a tachometer.** Leave the engine running.
3. **Find the slow-idling-speed adjusting screw.** It is located at the throttle shaft, resting against a flange on the shaft. Turn the screw in or out until the tachometer records the specified slow-idling speed. Turning the screw causes the throttle valve in the carburetor to open or close, changing the idling speed.

4. **Adjust slow-idling-speed screw** to move the idle-stop solenoid, if the carb has one, back and forth on its bracket—or turn a nut on the end of the solenoid plunger.

On some Ford models, idling speed is set

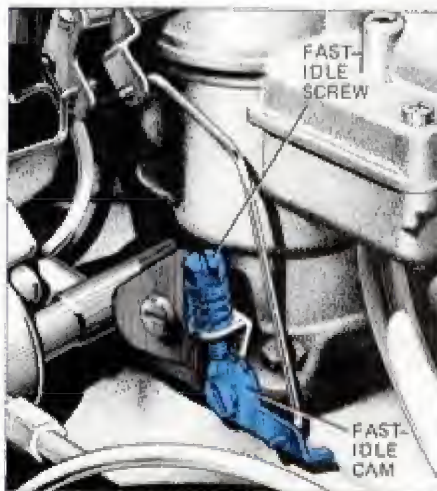
by disconnecting the solenoid wire and using an adjusting screw. Then, the solenoid wire is reconnected and adjustment to specification is made again, if necessary.

**Important:** Adjust slow-idling speed with the carburetor air cleaner in place.

### Adjusting fast-idling speed

**Note:** Check the emissions information label or service manual for specified fast-idling speed and conditions, if any, under which this adjustment is made. Adjust as follows:

1. **Connect a tachometer.**
2. **Remove the air-cleaner housing** from the carburetor.



To set fast-idle speed, engage screw on appropriate cam and check speed with tach. Rotate screw to set desired speed.

3. **Pull back the throttle linkage** and close the choke plate. Position the fast-idling-speed screw against the particular step of the cold-idle cam specified in service instructions. This step may be marked with an identifying mark, such as <

4. **Turn the fast-idling-speed adjustment screw** until the tachometer records the specified fast-idling speed.

### Adjusting the idle mixture

Cars made since 1968 have plastic caps over idle-mixture screws to limit the amount of movement and, therefore, the richness of the fuel mixture. If engine idling is not smooth and slow-idling speed has been adjusted, remove the carburetor air cleaner and turn one screw and then the other, if a second screw is



**Anti-stall dashpot is adjusted by the locknuts and the measuring gap between the plunger and the linkage plate.**

present, until idling becomes as smooth as possible. Replace the air cleaner and recheck slow-idling speed, which may change when idle-mixture screws are turned.

### Adjusting the dashpot

Some cars equipped with automatic transmissions normally have an anti-stall dashpot on the carburetor; it looks like a vacuum-break chamber. But unlike a vacuum break, the dashpot has no vacuum hose attached.

The dashpot prevents the throttle from shutting off suddenly if the accelerator pedal is released quickly after high-speed driving or rapid acceleration. If your engine stalls under these conditions, suspect the dashpot.

1. **Warm up engine** and let it idle.
2. **Push the dashpot plunger in against its spring** until it moves no further. There should be a clearance of  $\frac{1}{16}$  inch between the plunger and throttle-linkage flange. However, if stalling continues, reduce clearance to  $\frac{1}{32}$  inch. If the throttle seems to stay open too long as you remove your foot from the accelerator pedal, increase clearance to  $\frac{3}{32}$  inch.

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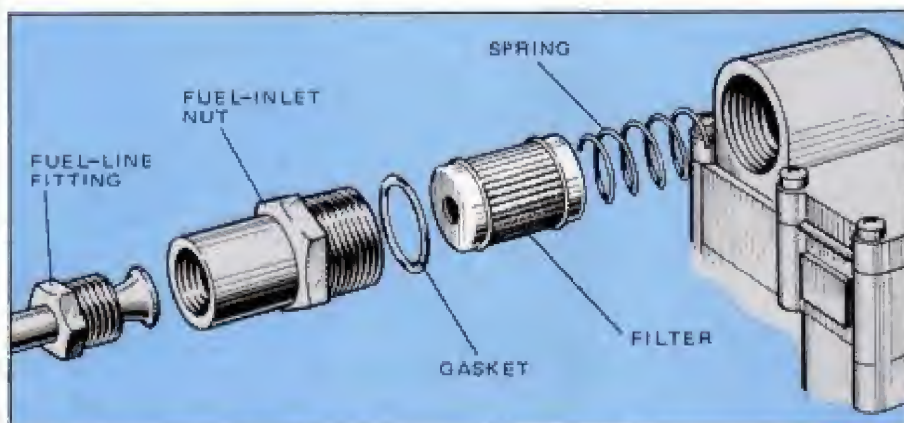
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## CAR CARE GUIDE 1980

### FUEL SYSTEM

# 24. Changing carburetor filters



Install the carburetor fuel filter in reverse order of removal. Check the spring for adequate tension before installing and replace gasket to prevent possible fuel leakage.

**M**ost cars have either an in-line fuel filter in the fuel line between the fuel pump and carburetor, or a fuel filter inside the carburetor inlet. Some have a fuel filter screwed into the carburetor inlet, but projecting so it is visible. This, too, is called an in-line fuel filter. A few models have the fuel filter in the fuel pump.

When a fuel filter gets partially blocked, the engine usually will stall, idle rough or lack power.

Since most filters cannot be cleaned and reused, the procedure involves installing a new filter.

### Servicing the in-line filter, I

In-line filters discussed here are positioned between the fuel pump and carburetor. To replace this type, do this:

1. Place a rag under the filter to catch gasoline that may drip.
2. Squeeze the spring clamps with regular pliers or hose-clamp pliers. Pull hoses off lines.
3. Remove hoses, filter and fasteners.
4. Install the new filter, which has new hoses and fasteners. Be sure the arrow on the filter points toward the fuel flow.
5. Start the engine; check the system for leaks.

### Servicing the in-line filter, II

To replace the in-line fuel filter which screws into the carburetor inlet, but projects so it's visible, do this:

1. Place a rag under the filter.
2. Slide the fastener away from its hold on the fuel line.
3. Unscrew the filter with a wrench. Discard.
4. Screw the new filter into the

carburetor. Tighten securely, but do not overtighten.

5. Connect and fasten the hose.

6. Start the engine; check for leaks.

### In-carburetor filters

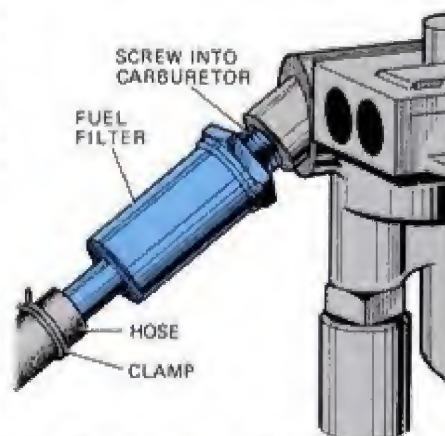
To replace an in-carburetor filter:

1. Place a rag under the fuel line at the carburetor to catch gasoline, and grasp the large nut with a wrench.

Note: If there is a filter in the carburetor inlet, the fuel line will screw into a large nut that screws into the carburetor.

2. Engage the fuel-line fitting nut with another wrench. Holding the large nut securely, loosen the fuel-line fitting nut.

3. When the fuel line is free, turn the large nut and remove it from the carburetor. The nut has a gasket (washer). Retrieve this gasket. It has to be used again.



Use caution when removing in-body fuel filters. Carb material is soft aluminum and can be stripped or cross-threaded.



# Greg Wessel, how long do you want your car to last?



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State Motor Oil. I've been so satisfied with the results that I put Quaker State in our new 'second' car right from the start. I hope it'll last as long as the convertible has, although I know it's a hard act to follow. I've got well over 100 thousand miles on the old car now, but I'm still not making plans to turn it in yet."

—Greg Wessel



Greg and Karen Wessel, Foster City, California. They're still enjoying their 1968 Camaro with over 100 thousand miles on it, while "breaking in" their '75 Opel on Quaker State—63 thousand miles worth.

## 4. Remove the filter and spring.

Discard the filter. If the spring has good tension, reuse it. If not, get a new one.

## 5. Install spring and new filter.

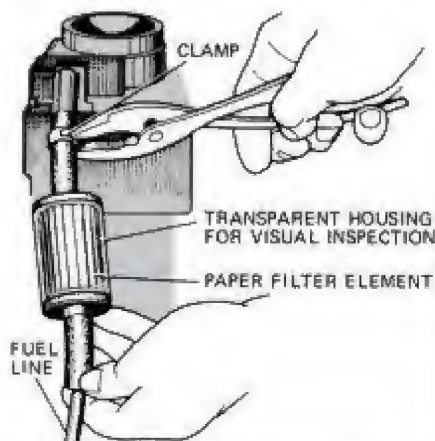
6. Reinstall the large nut and gasket. Tighten securely.

7. Reinstall the fuel line. Holding the large nut with a wrench, tighten the fuel-line nut securely. Start the engine and check for leaks.

## Cleaning the carburetor

Deposits build up in the carburetor to hamper the efficient delivery of fuel. When this happens, the engine will begin to stall, be hard to start and/or run roughly. This can be avoided by periodically cleaning the carburetor with a carburetor cleaner sold by auto-parts and accessories stores.

Some of these cleaning agents are added to gasoline through the fuel line. Others are poured into the carburetor throat. Another kind is a kit that force-feeds cleaner through the carburetor. The fuel line is disconnected and plugged, and the cleaning-agent can is attached to the fuel inlet by a hose.



In-line fuel filters of the transparent variety allow for frequent visual inspection. Only tool needed to change filter is pliers.

**Caution:** Some cleaners will damage the catalytic converter. Therefore, if your car is equipped with one, read directions on can to see if a cleaner should be used.

If you haven't replaced a fuel filter for a long time, you might see a brown sludge around the filter and the fuel-intake orifice. If so, you can be sure that the same brown sludge has been forming at the bottom of the float bowl and in the carb circuits.

If this sludge is left floating long enough, it will harden and crystallize into a white, chalky deposit. Even a carburetor cleaner won't remove the caked-up sludge.

Depending on the type of carburetor, there will be a power-enrichment valve or a main jet in the floor of the bowl. When cleaning out the sludge, use a wooden stick or screwdriver wrapped in a rag and keep the area soaked with solvent.

Be careful not to gouge or nick the valve or jet or enlarge the jet orifice. Use new gaskets when assembling the bowl cover. **PM**



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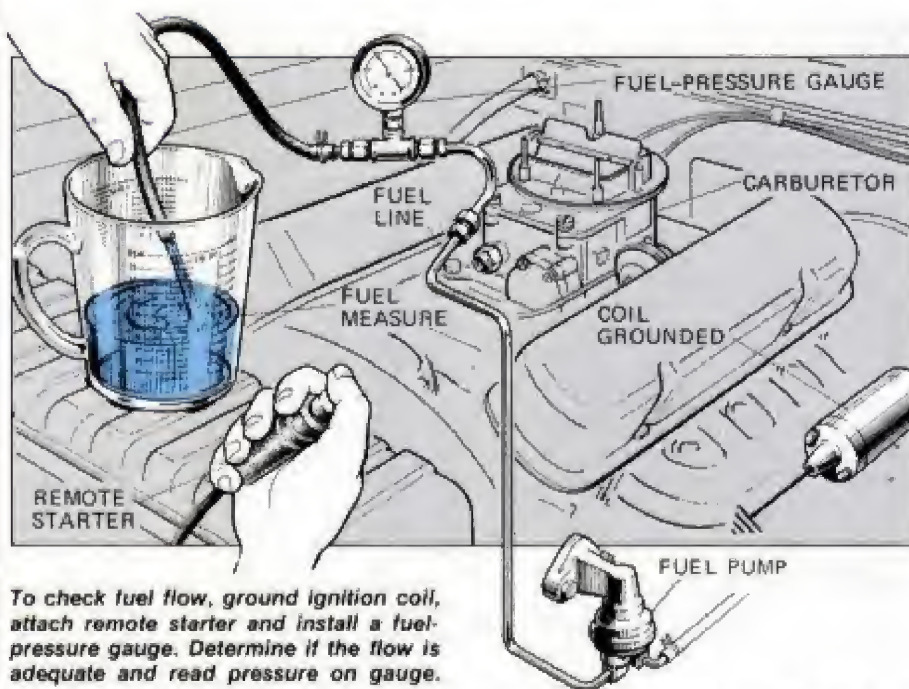
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# CAR CARE GUIDE 1980

## FUEL SYSTEM

# 25. Servicing fuel



To check fuel flow, ground ignition coil, attach remote starter and install a fuel-pressure gauge. Determine if the flow is adequate and read pressure on gauge.

**T**wo tests are used to check a fuel pump: fuel-flow test, which reveals if fuel is flowing freely, and a pump-pressure test that tells if the pump has sufficient pressure to supply adequate fuel.

Mechanical pumps used in most cars since 1970 are sealed. When they fail, they must be replaced. Such pumps in many pre-1970 models can be overhauled. If you can't find an overhaul kit, replace it with a sealed pump.

### Testing fuel flow

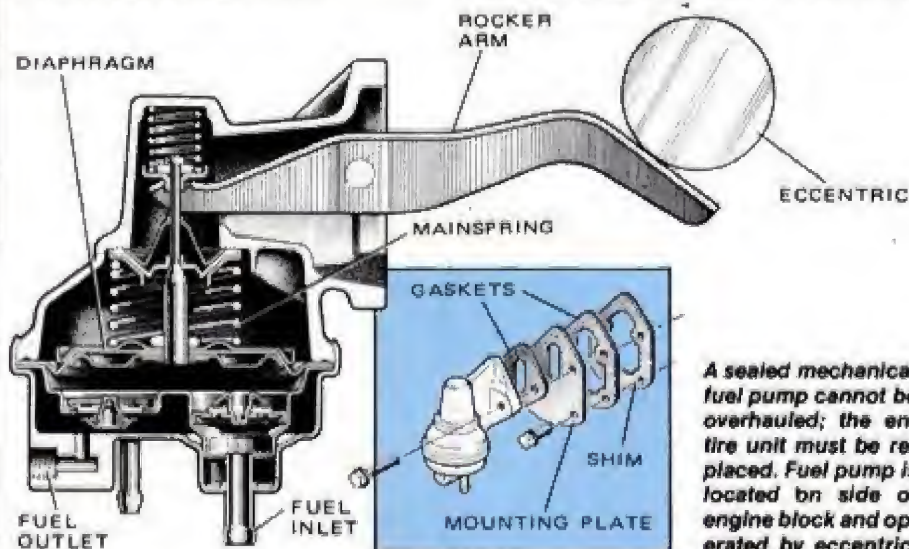
To test the flow of a fuel pump you suspect is defective, proceed as follows:

**1. Remove the ignition coil-to-distributor cable at the coil.** Connect a jumper wire to the cable terminal and its other end to a metal part of the engine. This assures that the engine won't start while the test is under way.

**2. Disconnect the fuel line at the carburetor** using two wrenches. One wrench holds the large fitting in place as the fuel-line fitting is turned with the other wrench.

**3. Attach a hose to the fuel line** and place the other end in a container.

**4. Crank the engine for 10 seconds as you judge fuel flow.** If the pump





# pump

is okay, there will be a strong pulsating flow of fuel. If there is just a trickle, or no flow, the pump is defective. Before replacing it, inspect the fuel line for kinks and internal blockage.

## Checking pressure

Follow manufacturer's instructions on connecting the fuel-pump pressure gauge. They require that you disconnect the fuel line at the carburetor, insert a T-fitting in the carburetor inlet, connect the fuel line to the other end of the T-fitting, and connect the gauge to the "T" part of the fitting.

Consult the service manual for the pump-pressure specification for your car. It will be between two and seven pounds per square inch (p.s.i.).

Start the engine and check the gauge. When it records specified pressure, shut off the engine and observe gauge action. The needle should stay put or slowly fall to zero. A gauge that records no specified pressure, or a needle that drops suddenly when the engine is shut off, indicates a damaged fuel pump that should be replaced.

## Replacing fuel pumps

1. **Raise and support the car if necessary.**
2. **Disconnect and plug the fuel-pump inlet line.** Use a golf tee or pencil stub.
3. **Remove the fuel-vapor return hose,** if one is present, from the fuel-pump fitting. Plug the end of this hose.
4. **Disconnect the fuel-pump outlet line** and gently bend it away from the pump, if necessary, for sufficient work clearance.
5. **Remove the mounting screws.**
6. **Tilt the pump up and pull it out of the engine.**
7. **Clean the pump mounting flange with a solvent.** Use a putty knife to scrape off old gasket material. Let the surface dry.
8. **Position a new gasket on the mounting flange,** first coating its surface with gasket cement so the gasket stays in place.
9. **Position the new pump,** making sure its arm engages the cam eccentric. If you have trouble getting the pump to seal, withdraw it and crank the engine to get the cam eccentric at a low point.
10. **Lift pump and install mounting bolts.** Tighten bolts alternately until they are secure.
11. **Unplug and connect inlet and outlet lines,** and the vapor-return hose.
12. **Start the engine.** While it runs, if you find any fuel leaks, tighten bolts or line fittings.

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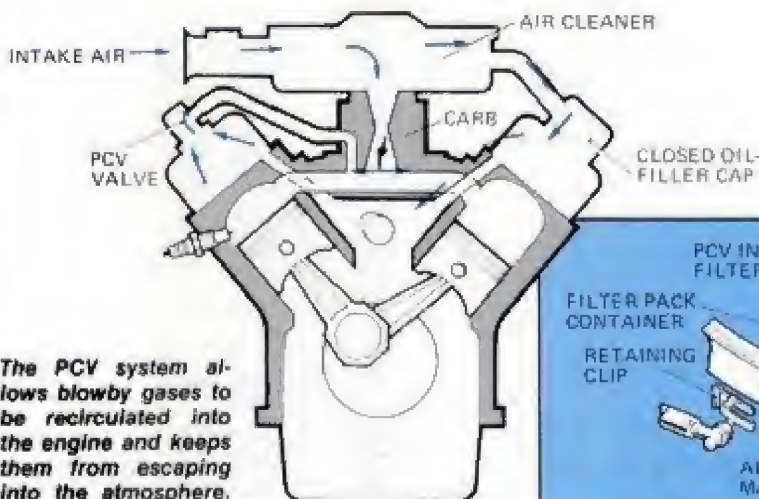
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# CAR CARE GUIDE 1980

## EMISSIONS SYSTEM

# 26. Servicing PCV valve



*The PCV system allows blowby gases to be recirculated into the engine and keeps them from escaping into the atmosphere.*

The purpose of the positive crankcase ventilation (PCV) system is to divert escaping exhaust gases (blowby) from the crankcase into the intake manifold, where the gases can be transferred to the cylinders for burning. The PCV system was the first auto-emissions control system installed on vehicles.

Prior to the advent of PCV in the early 1960s, blowby was ejected into the atmosphere through a ventilation hose. These exhaust gases were a main cause of air pollution.

The typical PCV system has a PCV valve, which controls the flow of gases. The PCV valve is located in either the rocker-arm cover or on the intake manifold.

The typical system also consists of a hose from the PCV valve to a port in the base of the carburetor; another hose from a breather cap in the rocker arm or valve cover to the carburetor air cleaner; and a filter to which the latter hose attaches, inside the carburetor air cleaner.

The PCV valve is the one part of the system that is most likely to fail. When it fails, or any other PCV component malfunctions, several engine performance problems result. These include loss of power, oil dilution, rough idling and stalling. It is, therefore, good maintenance procedure to inspect the PCV system at least twice a year.

### Testing

1. **Start the engine.** Let it warm up.
2. **Pull the PCV valve from its seat.** If the valve and attaching hose are in good condition, you will hear a hissing sound.
3. **Place your finger over the end of the valve.** You should feel moderate to strong suction.
4. **Turn off the engine** if there is no

noise or suction. Pull the PCV valve from the hose and shake it. A valve in good condition will make a clicking sound. A defective valve won't click. If there is no click, replace the valve.

5. **Check the hose for cracks** or kinks if the valve does click but there is no suction. Replace a damaged hose.

If the hose shows no damage, remove the hose and run a wad of cloth through it to clear a possible blockage. Reassemble the hose and valve.

6. **Remove the air-inlet hose** from the air cleaner. With the engine running, hold an index card over the hose opening. Wait a few minutes.

If the card is not pulled against the hose, the hose or breather cap is blocked. Check the hose to find out if there is damage and blockage.

7. **Remove the breather cap** and wash it in solvent. Let it dry.

8. **Remove the air-cleaner cover** and take the PCV filter out. This filter may be a cotton wad in a housing. Replace it. Sometimes, filter and housing are removed and replaced as a unit.

Instead, the filter might be a wad of bronze mesh installed in a hole in the air cleaner. Pry the filter from the hole and replace it, if it's clogged with dirt.

The PCV valve can also be used as a diagnostic tool. By knowing what to look for, you can spot certain signs of trouble before a problem becomes critical. If, for instance, you notice that the PCV valve frequently becomes heavily fouled with oil and sludge, it's an indication that too much blowby gas is getting through the rings. This could mean that the rings or the intake valves are not sealing properly and that they should be looked after.

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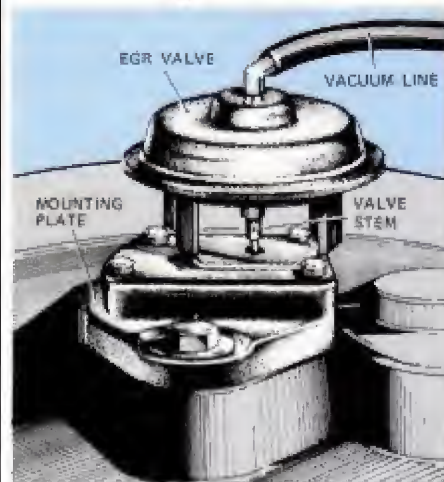
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<sup>\*</sup>Actual fuel savings depend on individual driving habits.



## CAR CARE GUIDE 1980

### 27. Servicing EGR system



To test EGR valve, tap the throttle and then check for free valve-stem movement.

The purpose of the exhaust-gas recirculating (EGR) system is to recycle exhaust gases into the intake manifold and, from there, to the cylinders to help reduce nitrogen oxide (NOx), a pollutant. Most cars built since 1973 have an EGR system.

The heart of the EGR system is a vacuum-controlled valve, called the EGR valve, that meters the small amounts of exhaust gas fed into the intake manifold. A buildup of exhaust deposits on the EGR-valve mechanism can cause the valve to stick. If the valve sticks in the open position, rough idling, engine hesitation and an increase in fuel consumption will result. If the valve sticks in the closed position, NOx emissions will increase.

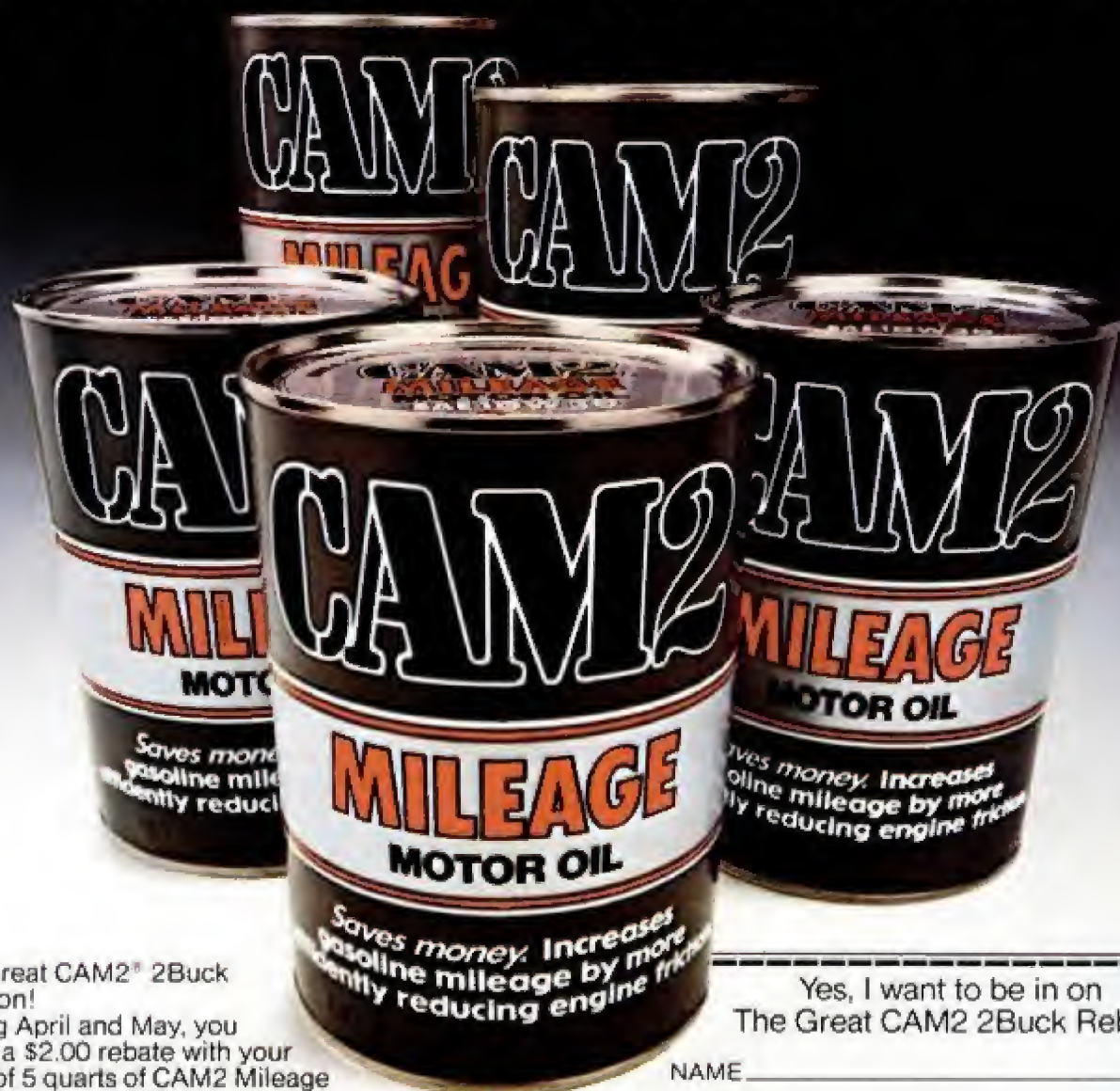
#### Servicing the EGR valve

1. **Locate the EGR valve**—behind the carburetor or on the intake manifold.
2. **Start the engine** and let it get warm.
3. **Place a finger on the stem of the EGR valve.** Most EGR valves have it exposed.
4. **Move throttle linkage by hand** several times to increase engine speed. If the EGR valve is free of deposits, the stem will move up when the throttle is tapped and return to position when the throttle is released.
5. **If this does not happen, unhook the vacuum hose** from the EGR valve and carburetor. Make sure the hose isn't clogged or damaged. Replace a faulty hose.
6. **Remove bolts holding the EGR valve** in place if the hose is in good shape. Remove the valve and examine the gasket under it. If the gasket isn't damaged, it can be reused.
7. **Clean exhaust deposits** from the valve stem and seal with a wire brush. Check passages for deposits. If you can't get the valve stem to move after cleaning, replace the EGR valve.

FM



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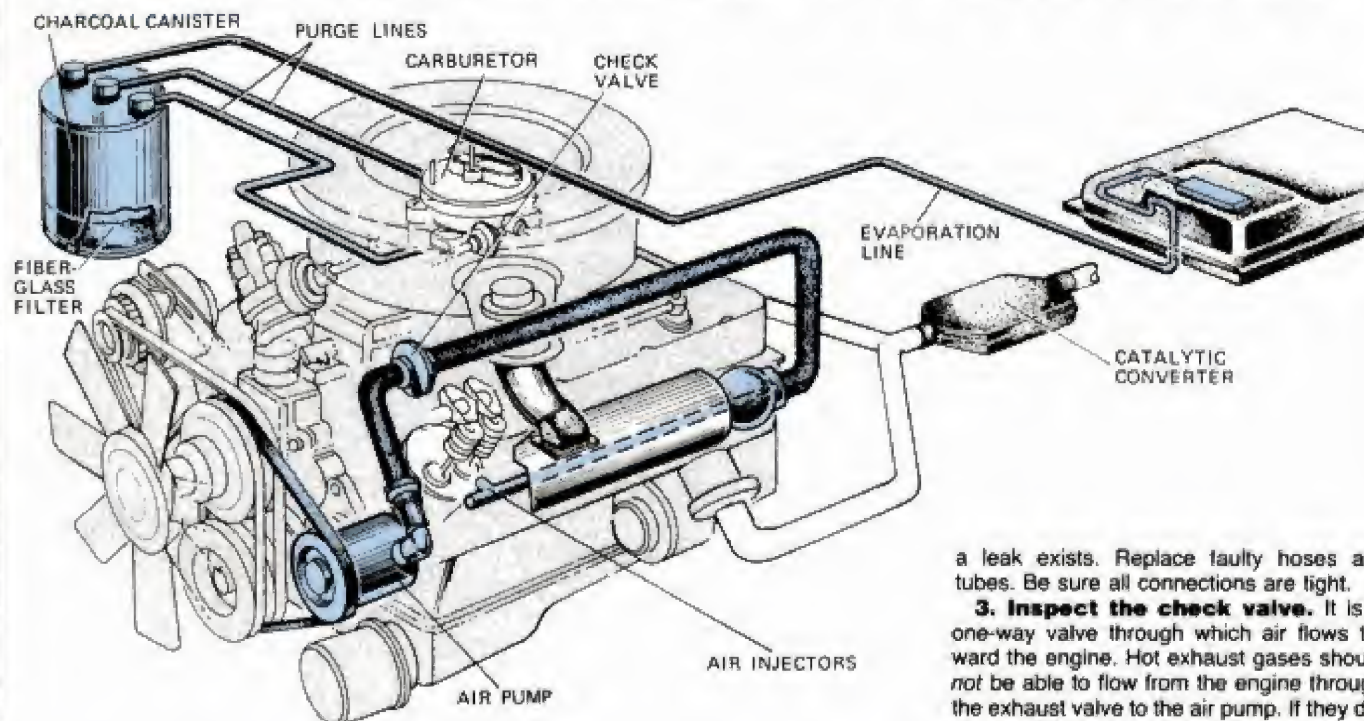
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# 28. Other emissions controls



In addition to the PCV and EGR systems, other emissions control systems with which you should be familiar are the evaporative emission-control unit, air-injection system and catalytic converter. Knowing what these systems do, how they do it and how to maintain them can help avoid problems.

### Evaporative emission control

The evaporative emission-control system prevents gasoline vapors from escaping into the atmosphere from the carburetor and fuel tank. The system is in operation whether or not the engine is running.

Most vehicles built since 1971 have an evaporative emission-control system. The heart of the system is a charcoal canister in the engine compartment that traps vapors when the engine is not running. When the engine is started, ambient air flows through a filter into the canister, where it picks up vapors and feeds them through tubes to the engine by way of the carburetor, where they are burned.

The one thing which upsets the functioning of the evaporative emission-control system is lack of filter maintenance. If the air filter in the charcoal canister gets plugged, a full complement of air is prevented from purging the canister of fuel vapors.

In most cases, it isn't necessary to replace the filter (or canister) any more frequently than once every 50,000 miles. To do this job, pull hoses from the canister, but be sure to tag them so they can be reconnected properly. Loosen canister bracket fasteners and remove the canister.

Turn the canister upside down. If the canister has a filter, you will find it at the base of the unit. Remove and replace the filter. If the filter is inside the canister, it is a nonreplaceable type. In this case, the canister must be replaced.

### Air-injection system

The purpose of the air-injection system is to reduce the levels of hydrocarbons and carbon monoxide in the exhaust gases after combustion. This is done by injecting air directly into the exhaust gases at each exhaust port, which causes further oxidation of the exhaust gases before they enter the exhaust system.

A damaged air-injection system usually does not cause poor engine performance, although in some instances there could be a loss of engine power. Instead, the level of hydrocarbon and carbon-monoxide emissions increases and a disturbing noise may come from the engine compartment. This noise is caused by the air pump.

Do the following if something goes wrong with your air-injection system:

**1. Inspect the drive belt for damage and tension.** When adjusting the belt, do not pry against the air-injection pump, which could be severely damaged. A loose or defective drive belt causes the air pump to operate at a reduced speed and may result in a noisy pump.

**2. Inspect air hoses and tubes** associated with the air-injection system for holes, cracks and deterioration. To test for a leak in a hose, spread a soapy water solution on the part. If bubbles form with the engine running,

a leak exists. Replace faulty hoses and tubes. Be sure all connections are tight.

**3. Inspect the check valve.** It is a one-way valve through which air flows toward the engine. Hot exhaust gases should not be able to flow from the engine through the exhaust valve to the air pump. If they do, there will be a loss of air supply and noise from the pump.

To test the check valve, disconnect its hose and blow through the valve toward the engine. Then suck back through the valve. The flow of air should be in one direction only—toward the engine. If there is a two-way flow, replace the valve.

**4. Test the pump.** To determine if the pump is operating, disconnect the air line, start the engine and accelerate to about 1500 rpm. If air flow increases as acceleration takes place, the pump is okay. If not, check belt tension, hoses and tubes. Then remove the pump for service.

### Catalytic converter

The single catalytic converter came on the scene in 1975. It converts hydrocarbons and carbon monoxide into carbon dioxide and water vapor.

Beginning with 1978 models, dual catalytic converters were used to treat nitrogen oxide, as well as hydrocarbon and carbon monoxide. The second smaller converter is called a "mini-ox" unit.

Catalytic converters don't last forever. However, to attain maximum life from a converter, avoid leaded gasoline. Unleaded gasoline is essential if converters are to last their expected service life, which is generally 50,000 miles.

If an emissions test determines that a catalytic converter is no longer doing its job, the entire converter must be replaced in cars other than GM and some AMC models. In GM and some AMC models, catalyst pellets are drawn out of the converter and new pellets are pumped in. Special equipment is needed.

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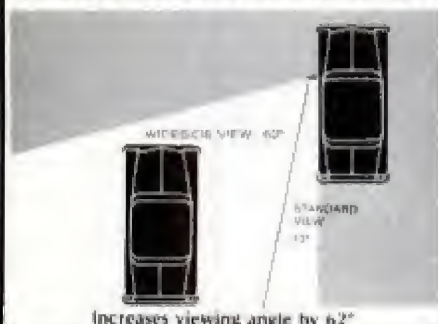
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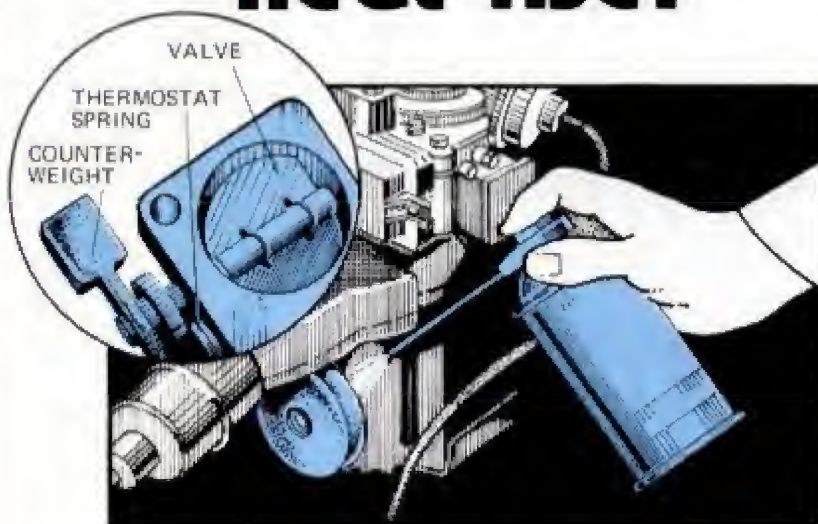
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# CAR CARE GUIDE 1980

## EXHAUST SYSTEM

# 29. Servicing heat riser



Servicing the heat-riser valve requires little more than an occasional coating with high-temperature, heat-riser-valve lubricant. If valve is stuck fast and can't be moved, replace the entire unit.

The heat-riser valve, which is also called the manifold heat-control valve, is a device installed on many cars to assist engines in warming up.

The heat-riser valve is a thermostatically controlled mechanism in the exhaust manifold. When a cold engine is started, a thermostat spring keeps the valve plate closed to prevent hot exhaust gases from leaving the engine. Instead, exhaust gases are detoured to a chamber that surrounds the intake manifold where vaporization of the fuel mixture takes place. Hot exhaust assists in the vaporization of fuel.

As the engine gets warm, heat acts on the thermostat spring, causing it to lose tension. This permits the heat riser to open, allowing exhaust gases to pass out through the exhaust system.

### Possible Malfunctions

If the heat-riser valve sticks in the open position, the following problems may occur:

- A cold engine may have trouble warming up and may stall or idle rough.

- Fuel economy may suffer, since raw fuel, which would otherwise be vaporized, may be drawn out through the exhaust or may run past piston rings into the crankcase. Raw gasoline may also contribute to sparkplug fouling and oil dilution.

- Flat-spot acceleration (hesitation on acceleration) may occur during longer warm-up periods.

If the heat-riser valve sticks in the closed position, the following problems may occur:

- Loss of engine power, caused by too much heat acting on the fuel mixture after the engine gets warm.

- The restricted exhaust system may cause backfiring through the carburetor, and in se-

vere cases, a stuck heat-riser valve may lead to overheated sparkplugs, burned valves and detonation.

### Testing the heat riser

1. **Move the heat-riser counterweight by hand** when the engine is cold. You'll find the counterweight beneath the exhaust manifold. It should move freely, not sluggishly.

2. **Warm up the engine.** Then allow it to run at idle.

3. **Watch the heat-riser counterweight** as someone in the car accelerates and decelerates the engine quickly. The counterweight should rotate.

**Caution:** Do not touch the exhaust manifold, which will be hot enough to give you a severe burn.

### Servicing the heat riser

If the heat-riser valve sticks, try forcing it by gentle tapping with a hammer. First, tap the end of the counterweight; then, tap the face of the counterweight. Apply heat-control-valve lubricant to the heat-valve shaft. Tap the counterweight again. Then, try moving it. Repeat the procedure a couple of times before giving up completely and replacing the heat riser.

To treat a sluggish mechanism, lubricate both ends of the shaft to which the heat-riser counterweight is connected. This is done with the engine cold. Then, rotate the counterweight by hand until the mechanism moves freely.

The best way to keep the heat-riser valve functioning properly is to lubricate the shaft periodically. If the shaft is kept well lubricated, the heat-riser valve will rarely bind and cause trouble.

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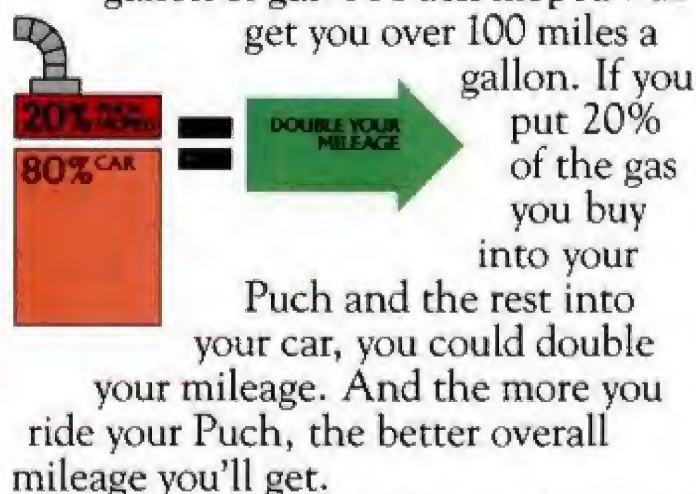
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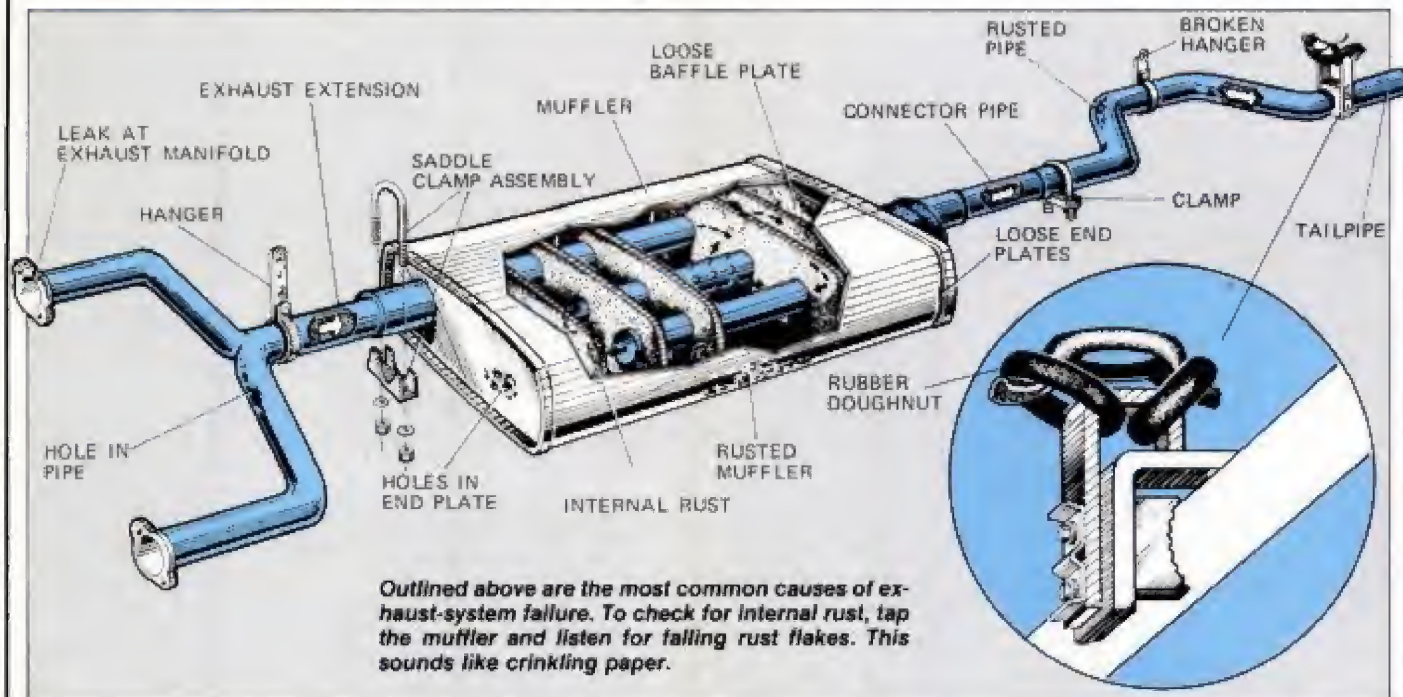


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# 30. Servicing exhaust system



**A**n exhaust system usually doesn't fail all at once. So there is a chance you'll be able to reuse some parts. The job of replacing an exhaust system, totally or in part, is dirty and takes muscle. However, it is not complicated, and doing the job yourself will save money.

### Inspecting the system

**Caution:** The exhaust system must be cold during inspection or you may receive severe burns.

Inspect the system for holes. As you check the muffler, look closely at the end plates, because it is here that deterioration frequently takes place. Push in gently on each end plate as you look for breaks around the perimeter and tubes.

Draw your hand over pipes and muffler. Rust flaking off is a sign that the component is near failure and needs to be replaced.

Tap the muffler with the heel of your hand and listen for pitter-patter sounds made by flakes of rust falling inside the muffler. If there is a rattling sound, there's a loose tube or baffle inside. Either sound suggests the muffler should be replaced.

Now, tap the muffler with a metal tool. A dull sound, rather than a metallic ring, is another sign of internal deterioration. The muffler will soon wear through, causing an exhaust leak; consider replacing it now.

If you're hearing rattling noises coming from the underside of the car, check to see if an exhaust-system part is hitting the chassis or body. A bracket holding the part may have failed. Gently push pipes and muffler up to see if anything is hitting. Then, service the respective bracket, or brackets.

### Replacing exhaust system

**1. Raise the car up and place jack stands at all four corners.** Do not work beneath a car supported by bumper jacks.

**2. Let the rear axle hang free.** Maneuvering the tailpipe will be easier. Judge if removing the rear wheel-and-tire assembly will provide easier access.

**3. Lubricate frozen clamps and bolts** with penetrating oil. Loosening these may be difficult, but try to reuse as much of the original hardware as possible.

**4. Use deep, six-point sockets** rather than open-end or box wrenches to remove fasteners. If you are removing the exhaust system from an imported car, you will have to use metric-size tools. **Caution:** Wear goggles to protect eyes from rust and oil.

**5. Warm up the engine to free fasteners** at the exhaust-pipe/exhaust-manifold connection. However, be careful not to touch the hot manifold.

**6. Use a chisel or saw to cut pipes,** if you are replacing the entire exhaust system and there is no catalytic converter. You can also cut off fasteners. If the system incorporates a catalytic converter or converters that do not need replacing, be careful not to damage the converters and attached pipes. Use penetrating oil to remove fasteners.

**7. Grab any broken studs with locking pliers,** and, if possible, apply heat with a propane torch to the area around the stud. Try working the stud loose.

If this doesn't work, drill the stud out by knocking a pilot indent in the broken stud with a center punch. Use a drill bit a little smaller than the stud. The broken stud will usually

come out of the hole as you back out the drill bit. Then, use a thread reamer to remove any part of the stud remaining in the hole. This tool is available at auto-parts and accessories stores and hardware stores. Screw a new stud in place.

**8. Restore roundness of re-usable pipes with a pipe shaper.** If you have to cut away a tailpipe from a deteriorated muffler, cut at the weld line. When assembling parts, coat pipe connections with exhaust-system sealer and install a U-clamp. Tighten, but not excessively.

### Installing exhaust

**1. Work from the engine toward the rear of the car.** Don't tighten fasteners. Rather, install parts loosely. See that they are straight.

**2. Check clearance between pipes and chassis** by placing your hand between each component and the adjacent area. Your hand should fit easily, with enough room to move an inch or two up and down. Be sure there is ample clearance around the rear axle and fuel tank.

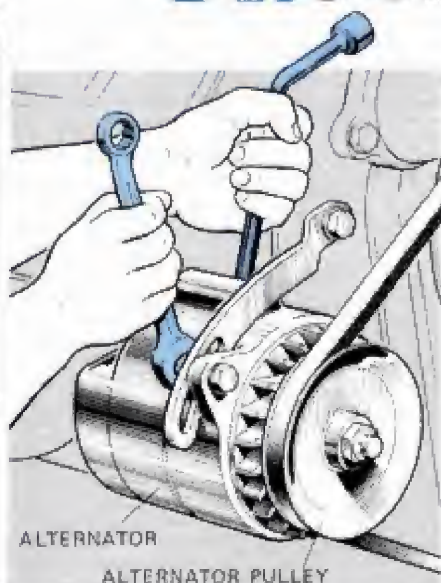
**3. Tighten components securely after checking alignment and clearance.** Be careful not to overtighten. You may crush pipes.

**4. Start the engine and check for leaks** by placing your hand lightly around pipe joints. You will feel a leak if one is present. Reposition the clamp.

**5. Test-drive the car and listen for rattles and squeaks** from underneath, indicating that an exhaust-system component is not sufficiently tight and is hitting against an adjacent area. **PM**



# 31. Servicing drive belts



ALTERNATOR  
ALTERNATOR PULLEY

To adjust alternator belt, loosen bolt, pull alternator tight with a bar, tighten bolt.

When a belt snaps or loses tension, the system the belt serves stops or works at reduced efficiency. Therefore, it's best to service belts before they fail.

### Inspecting belts

Examine belts on top, side and bottom surfaces (twist belts) for the following damage which, if found, calls for a replacement:

- Cracks—a cracked belt flexes excessively and may split apart.
- Peeling—as layers peel away, the belt weakens and will eventually snap.
- Splits—a split can work through the belt rapidly, causing the belt to separate.
- Glaze—a slick underside or side surface causes a belt to slip.
- Oil-soaked—oil on a belt causes the belt to soften.

### Replacing a belt

Make sure you get the exact-size belt needed for your car. Loosen mounting bolts of the particular accessory or an idler pulley. Push in so the old belt falls; then remove it.

With the accessory or idler pulley all the way in, the new belt should just fit onto the pulleys. However, you may have to pry the new belt over a pulley rim with a screwdriver. A new belt should have a tight fit.

Pull back on the accessory or idler pulley and tighten the belt to the recommended new-belt specification (see the service manual). Run the engine for at least 10 minutes; then check belt tension again to see that it meets the used-belt specification (see the service manual). There are some deviations from this procedure, as follows:

- Some setups have an access hole in the adjusting bracket into which the pry bar is placed. This is to assure that the pry bar is positioned against a part of the accessory that can withstand pressure, and not against

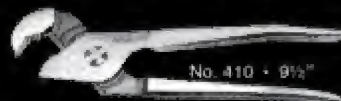
something fragile, such as the air-cooling fins of the alternator.

- Other setups have a cam-type adjuster on the idler pulley. Loosen the retaining nut and turn the adjuster to attain correct adjustment. Then tighten the retaining nut.

- Still other setups have a stud-nut adjuster on the power-steering pump, eliminating the need to apply any tension with a pry bar. Loosen the retaining nut and use a wrench to turn the stud-nut adjuster to tighten or loosen the drive belt.

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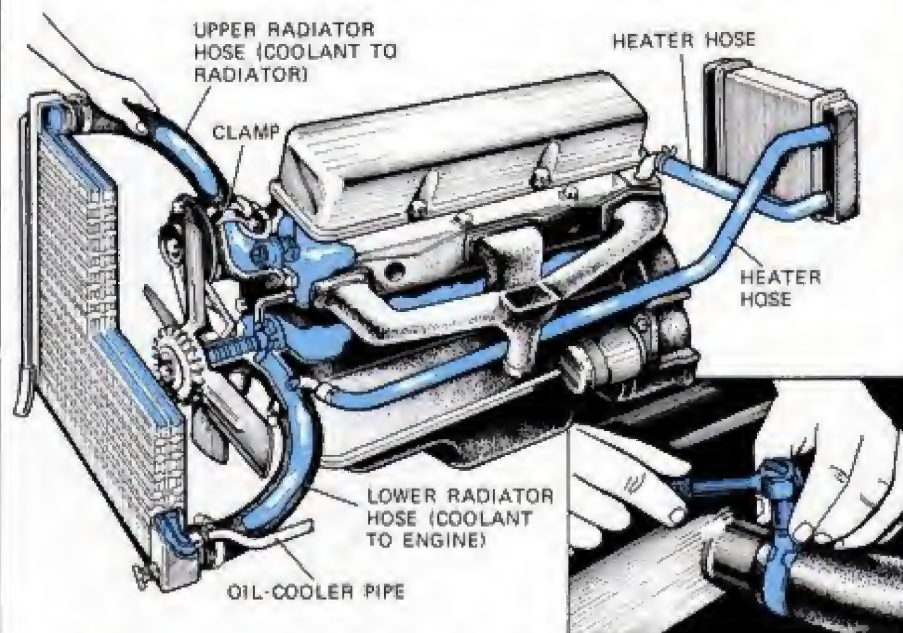
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## CAR CARE GUIDE 1980

### COOLING SYSTEM

# 32. Replacing coolant hoses



Cooling-system hoses should be checked frequently. Examine them for cracks, softness and brittleness by squeezing each one firmly from one end to the other.

**T**here are four or five cooling-system hoses in a car. Two of them are radiator hoses: One delivers coolant to the engine, while the other transfers hot coolant from the engine to the radiator. The two hoses that transfer coolant to and from the heater are also part of the cooling system. In addition, there may be a bypass hose from the water pump to the engine.

Hoses are vital to engine operation. If a hose splits, allowing coolant to be lost, you will be stranded, since an engine without coolant will quickly overheat and seize. For this reason, it is wise preventive maintenance to examine hoses frequently. Some carmakers even recommend that all hoses be replaced every two years to avoid an emergency situation. Incidentally, it's a good idea to carry duct tape in the car for temporary repairs if a hose does split.

### Inspecting hoses

Examine hoses for cracks, softness and brittleness by squeezing each one firmly along its entire length. Hoses should be resilient and flexible. If cracks appear as you squeeze a hose, replace it.

With the engine warmed up and running, check hoses for bulges. A bulge signals that a hose is weak and likely to burst.

Have someone in the car raise the engine as you examine the lower radiator hose. If it flattens out, the spring inside the hose is weak. Replace the hose, since coolant flow is being curtailed. A collapsed lower radiator

hose causes overheating during higher speed driving.

**Caution:** When checking the lower radiator hose, keep hands away from fan, belts and pulley. Don't wear clothes that dangle.

As you check each hose, examine its clamps for coolant leakage. If a clamp is loose, tighten it; if distorted, replace it.

### Replacing a hose

To avoid burning yourself, replace hoses with the engine cold.

**1. Drain coolant** to below the level of the hose that's being replaced. If coolant is to be reused, drain it into a clean container. To avoid losing any coolant, push a length of clean hose over the radiator petcock and place the other end in a container.

**2. Open the hose clamps**, or cut them off if they are going to be replaced.

**3. Pull the bad hose off its connectors** by twisting and pulling. If the hose is stuck, slit it with a utility knife first.

**4. Clean metal connectors** with a wire brush or emery cloth.

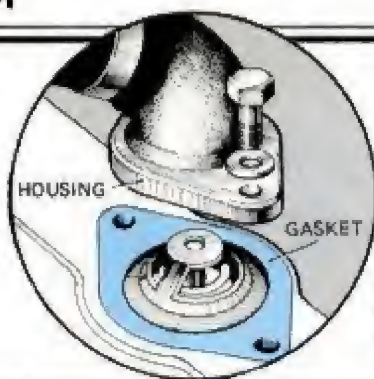
**5. Slip clamps onto the new hose** and push the hose onto its connectors. If the hose is tight and doesn't push home, soak it in hot water a while.

**6. When the hose is seated, position clamps** about 1/4 inch from the ends of the hose and tighten the clamps.

**7. Pour coolant back into the radiator.** Start the engine and let it run as you examine that system for leaks. **PM**



# 33. Checking thermostat



The thermostat is centered in its housing on the engine block.

**T**he purpose of the thermostat is to trap coolant in a cold engine. When the engine reaches a temperature, the thermostat opens to let coolant flow to the radiator.

If the thermostat valve gets stuck in the closed position, coolant is trapped inside the engine and the engine will overheat. If the valve gets stuck in the open position, the engine warms up very slowly, if at all.

You can get an indication of whether the thermostat is working by removing the radiator cap (with the engine cold) and inserting a thermometer into the coolant.

Start the engine and watch the thermometer. Keep squeezing the upper radiator hose. When the thermometer reaches the temperature at which the thermostat is supposed to open (give or take 10°), you should feel coolant surging through the radiator hose.

**1. Drain about half the coolant** from the radiator with the engine cold.

**2. Remove bolts holding the thermostat housing.** Remove the housing.

**3. Lift the thermostat from the housing.** Hold the unit to a bright light. The thermostat valve must be closed. You should see no light passing around the valve. If the valve doesn't close, replace thermostat.

**4. Note the temperature reading** on the thermostat. This is the temperature at which the thermostat is designed to start opening. Thermostats are built to be fully open about 20° above rated temperature.

**5. Tie the thermostat to the center of a wood dowel.** Insert a .003-in. feeler gauge between the thermostat valve and housing. Tie a string to the feeler gauge.

**6. Place the thermostat in a pan of water.** The thermostat must be fully immersed, but it should not rest on the bottom or against the sides of the pan. Place a thermometer in the pan and heat the pan.

**7. Pull the feeler gauge free** when the thermometer shows that water is heated to the temperature stamped on the thermostat housing, plus or minus 5°. If you can't, replace the thermostat. The thermostat valve should be wide open when water reaches 20° above the rated temperature, give or take 5°.

**8. Scrape pieces of old gasket** from the surface of the thermostat housing and engine. Wipe surfaces with solvent.

**9. Place the thermostat in the housing,** spring end facing out. Note any marking that instructs you to point the thermostat in a particular direction.

**10. Place down new gasket on housing.** Be sure that holes in the gasket line up with holes on thermostat housing.

**11. Refit the housing and tighten the bolts.**

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### 34. Checking for coolant leaks

The cooling-system pressure tester pressurizes the cooling system, also reveals any leaks.



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**O**bviously, it isn't necessary to use a pressure tester every time. Some leaks are readily apparent because of the coloring of coolants. When coolant dries, it leaves corrosive-looking deposits at a leak site.

Look for signs of leaks at these places:

- Radiator seams.
- Where upper and lower (or side-by-side) radiator tanks are soldered to the core.
- Around radiator hose connections.
- At petcocks.
- Around the thermostat housing.
- Around engine drain plugs or freeze plugs.
- At transmission oil cooler connections at the radiator.
- Around the water pump.
- At heater-core seams.
- Around heater hose connections.

If you find no leak, but still suspect one, use the cooling-system pressure tester.

#### How to use the tester

1. **Remove the radiator pressure cap** (engine cold).
2. **Check coolant level.** Add coolant, if necessary.
3. **Start the engine** and allow it to warm up. Turn the engine off and attach a pressure tester to the radiator filler neck.
4. **Examine the radiator pressure cap** to determine the prescribed pressure for the engine. It should be marked on the cap. If not, check the service manual.
5. **Pump the handle of the tester** until the gauge records the specified pressure. Don't exceed this rating. Excessive pressure may cause radiator seams to spout leaks and hoses to rupture.
6. **Look for coolant leaks at the areas listed above** with the system pressurized. If a leak still is not apparent, check the pressure tester gauge. If it holds the rated pressure for at least two minutes, there is no leak. If it doesn't and no leak is apparent, the leak may be internal (cracked cylinder head, water gasket or block).
7. **Release pressure** as described in the tester's instruction book. Remove the tester from the radiator.

#### Testing the radiator cap

1. **Remove and wash the cap in water.** Examine its gasket. If the gasket is cracked or brittle, replace the cap.
2. **Attach the cap to the cap adapter** of the pressure tester. Pump the pressure tester until the gauge records the rated capacity of the cap (marked on the cap housing). This pressure reading must maintain itself at least two minutes. If the needle drops before this time, replace the cap. **PM**



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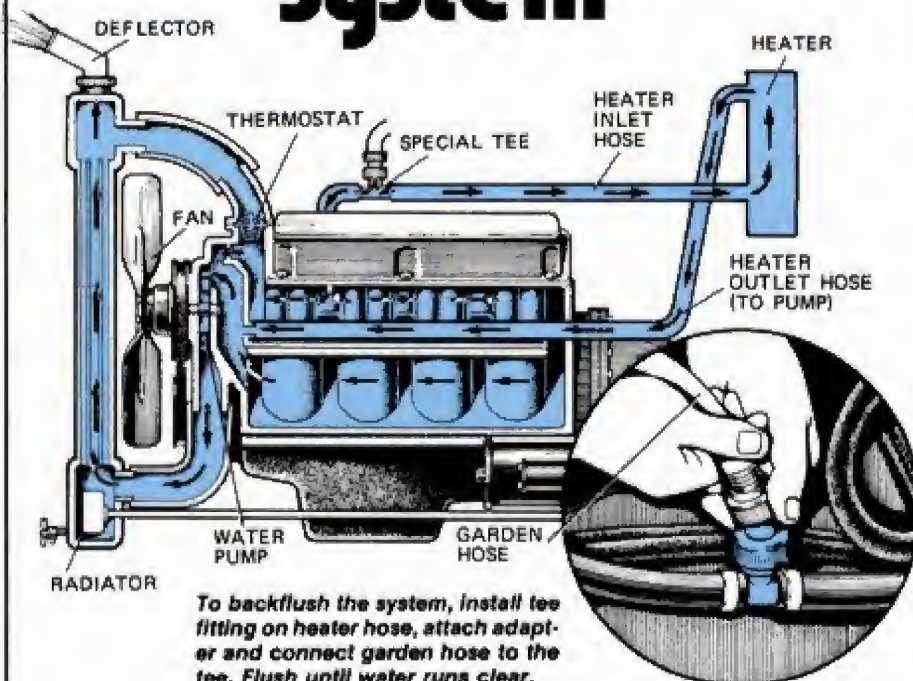
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# CAR CARE GUIDE 1980

## COOLING SYSTEM

# 35. Flushing the system



To backflush the system, install tee fitting on heater hose, attach adapter and connect garden hose to the tee. Flush until water runs clear.

**C**ar manufacturers recommend that you drain and flush the cooling system every two years. The job has been made easier for the Saturday mechanic by development of a flushing kit.

After the cooling system is drained and flushed, new coolant should be added. The maximum life of a high-quality ethylene glycol coolant is two years. After this time, additives which protect the system from rust break down.

### Draining and flushing

**1. With the engine cold, set the heater control ON HEAT** to assure that coolant in the heater core will also drain.

**2. Remove the radiator pressure cap.**

**3. Open the petcock** at the base of the radiator.

*Note:* If the radiator is not equipped with a petcock, remove the lower radiator hose to drain the radiator.

**4. Remove the drain plug** or plugs, if possible, from the engine block. Since this is not possible on most engines, it becomes necessary to backflush the engine with a flushing kit to drain coolant.

**5. Fit the flushing tee from the kit to the heater supply hose.** This is the hose that runs to the engine block. It is not the one that is connected to the water pump.

To fit the flushing tee, cut the heater supply hose, insert the tee and tighten the clamps that hold the tee. Face the tee so water which may escape from it won't run on the alternator.

*Note:* Flushing tees are available in three sizes to match inside diameters of heater hoses. Determine the size you need by measuring the outside diameter of the hose and subtracting  $\frac{3}{8}$  in.

**6. Attach a garden hose to tee** using the adapter in the kit. Make sure that the heater is on, radiator cap is off and radiator petcock is open.

**7. Attach the deflector to the radiator filler neck.** The deflector, which is part of the kit, throws water away from the engine.

**8. Turn on the water and allow it to flush the engine** until water pouring out the deflector begins to run clear.

*Note:* If your car is equipped with air conditioning, let the engine idle while flushing.

**9. When flushing is complete, turn off the water** (and engine, if it's been running). Remove the deflector from the radiator and adapter from the tee. Allow water to drain completely from the radiator.

**10. Close the radiator petcock** (or reinstall the bottom hose). Now, add a 50 to 50 mixture of ethylene glycol coolant and water to the radiator until the solution starts to pour out of the tee. Cap the tee with the cap supplied in the kit. Leave the tee in place.

**11. Squeeze the upper radiator hose to expel air.** Then add more coolant, if necessary, to bring the solution to the fill mark on the radiator or to just below the radiator filler neck.

**12. Run the engine until the upper radiator hose feels warm.** Shut off the engine. Remove the radiator cap carefully and recheck the coolant level.

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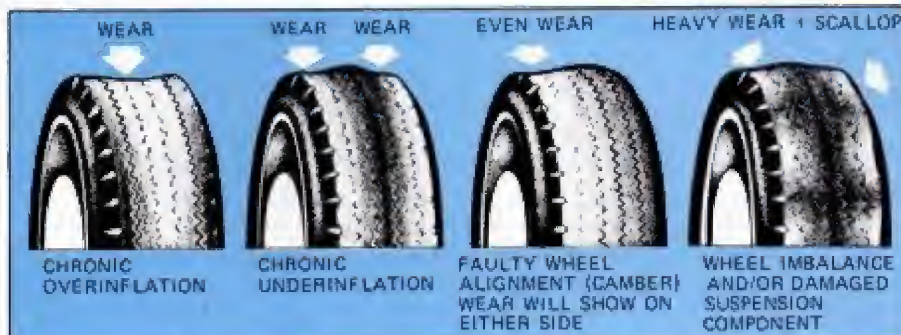
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# CAR CARE GUIDE 1980

## SUSPENSION

# 36. Servicing tires



Tread wear can indicate suspension problems. Faulty wheel alignment will show up as a biased tread pattern. An out-of-balance tire will show as scallops or cupping.

With proper maintenance, modern radial tires generally last at least 40,000 miles. Some tire companies and automobile manufacturers advocate rotating for maximum tread life. Others, including some manufacturers of front-end alignment equipment, claim that rotating tires is a waste of time.

The one area of agreement between the two is to not rotate tires of cars with front-wheel drive. If you don't rotate, you may get as much as 100,000 miles of service from tires on the rear wheels, assuming the car is equipped with radial tires.

## Maintaining tires

To get maximum life from tires, do the following:

- Check air pressure every 30 days with a good quality pressure gauge. Follow the air pressure recommendations of the car manufacturer. They are printed in the owner manual and, usually, on a decal somewhere in the car.

**Important:** Check air pressure when tires are cold. A cold tire is one that hasn't been driven more than three miles for several hours. It is best, therefore, to check air pressure in the morning before the car is driven.

- Replace a tire if it has the following physical damage: bulged areas, cuts that extend into the fabric and excessive tread wear. Tread wear that leaves tread depth  $\frac{1}{16}$  in. or less across two adjacent tread ribs is considered excessive. Measure tread depth by placing a penny (Lincoln's head down) in the rib at different spots. If the top of Lincoln's head shows, the tread depth is too shallow.

- Check each tread rib for embedded stones or other foreign material. Pry them out with a screwdriver.

- Remove valve caps and wet valve stems. If water bubbles, there is a leak. Replace the valve core. Then, inflate the tire to specified pressure.

## The story tires tell

Tread wear patterns can tip you off to a mechanical problem that is causing abnormal tire wear. If the problem is caught and

corrected early enough, the tire may still afford adequate service.

The following describes the types of tread wear you're likely to encounter:

- Smooth stripes across the face of the tire. These are wear bars. They appear when the tire is nearing the end of its life. Bars signify normal tire wear.

- Tread wearing more in the center of the tire than at the edges. The problem is chronic overinflation.

- Tread wearing more at the edges than in the center. The problem is chronic underinflation.

- Tread feathering along edges. Check wheel alignment.

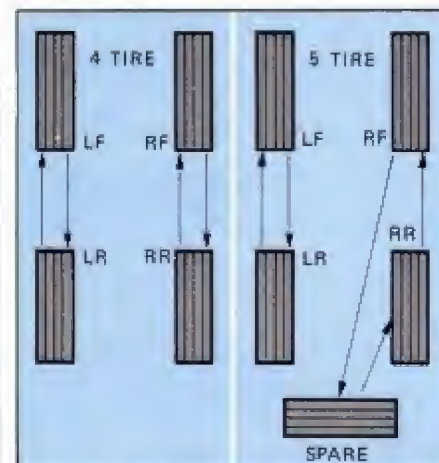
- Tread wearing along one edge, inside or outside. Check wheel alignment (camber adjustment, in particular).

- Tire wearing unevenly over one or more spots. Check wheel balance.

- Scallops (cupping) developing evenly over an area. Check for a damaged suspension system component.

- Flat-spot developing. Analyze the way you accelerate and stop the car. A flat spot often means that you are spinning tires when you accelerate the car or you are making screeching stops.

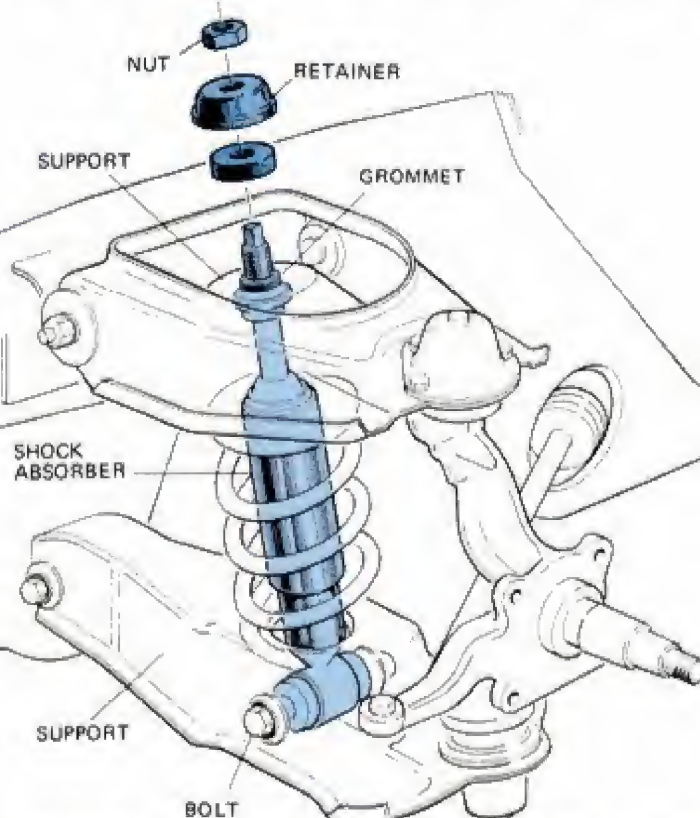
PM



Radial rotation patterns are for four tires at the left and for five tires at the right.



# 37. Installing new shock absorbers



Put penetrating oil on studs and bolts before trying shock removal. Support lower A-arm to remove spring preload. If nut is frozen solid, it must be cracked off.

In most cars, replacing shock absorbers is not complicated. The best way to tell if shocks have lost their ability to sustain the oscillations of car springs is to analyze vehicle road performance.

Does the car dip sharply when making a quick stop?

Does the car seem to bottom when going over bumps and railroad crossings?

Does the car continue to bounce up and down after going over bumps and dips in the road?

If the answer to any of these questions is yes, remove one of the shock absorbers and push it in and out. If resistance is much less than a comparable new shock, replace it. Remember, though, to replace shock absorbers in pairs—if one on the front of the car has to be replaced, replace the other front shock, too. Replacing shocks in pairs gives a car balanced performance. Shocks should also be replaced if there is physical damage.

**1. Apply penetrating oil to fasteners.** Let the oil work for a few hours.

**2. Raise and support the car.** If you are replacing the rear shocks of a car with a rear differential, use a jack near each shock

absorber to lift the axle. This releases pressure put on the shock by the rear axle.

**3. Unbolt the lower fastener.**

**4. Unbolt the upper fastener.** If you can't spot the upper fastener beneath the car, get to it through the engine compartment or trunk. If the upper part of the shock has a stud mount, you need two wrenches to loosen it.

Apply one wrench to the large mounting nut and turn. The other wrench, applied to the stud, keeps the shock from twisting.

**5. Adjust shocks for the type of ride you desire,** if you are installing adjustable shock absorbers. Usually, adjustment is done by securing the shock in a bench vise and compressing and twisting it.

**6. Secure top fasteners first** to install shocks. Then secure bottom fasteners. Tighten fasteners, but do not overtighten. Bushings should not bulge. Stop tightening as soon as bushings swell slightly.

**7. Install rubber caps for fasteners** if they came with the shocks. They protect fasteners from rust. If caps are not available, coat fasteners with silicone caulking, which helps to retard rust.

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## CAR CARE GUIDE 1980

### 38. Checking



*Tighten master-cylinder brake lines if the fittings leak. Do this carefully because these fittings are easily rounded.*

**Y**ou should be aware of brake performance at all times. If a problem that may be brake-related occurs while you're driving, at your first opportunity conduct a thorough examination before the condition becomes dangerous. In addition to staying alert to developing brake problems, conduct a brake stationary test every 12,000 miles, as explained here.

#### Stationary test

**1. Apply heavy pressure to the brake pedal** with the car at a standstill. Allow the engine to run at idle speed if the car is equipped with a brake-assist unit (power brake). If the car doesn't have power brakes, you need not start the engine.

The pedal should feel firm. If it feels spongy or springy, remove the master-cylinder cover and see if the cover has vent holes. If so, be sure that none of these holes are blocked.

**2. Test brake-pedal firmness again.** If the pedal still feels spongy, inspect brake hoses for weak spots that could be the cause. As someone in the car applies the brake pedal, trace each hose for bulging. Replace a weak hose.

**3. Finally, bleed brakes to eliminate trapped air** if sponginess continues. Air can be trapped in the system if any brake line on the car is loose.

As you check the brake pedal for sponginess, notice brake-pedal height. If the pedal goes too far toward the floor, brakes probably have to be adjusted.

#### Testing for leaks

**1. Run the engine at idle if you have power brakes.** If not, don't run the engine.

**2. Hold your foot on the pedal for 15 seconds** with light pressure. The pedal should not move.

**3. Apply heavy pressure for 15 seconds.** Again, the pedal should catch and not move.



## brakes

If the brake pedal falls away when pressure is applied in either case, there is a fluid leak.

**Tracing a fluid leak**

To find a fluid leak, you should proceed as follows:

**1. Check fluid level** at the master cylinder. Low fluid level helps to confirm the existence of a leak.

**2. Tighten brake-line connections at the master cylinder.** If you have any loose connections you can expect some loss of fluid.

**3. Check brake lines and hoses** while someone applies firm pressure on the pedal. Examine connections closely. If a connection is leaking, try tightening it. If this doesn't stop the leak, replace the line or hose.

**4. Check wheel cylinders for leaks** if the car has drum brakes. Most of today's cars have disc brakes on front wheels and drum brakes on rear wheels. Remove wheel assemblies and pull back wheel cylinder boots. If fluid leaks, the cylinder is defective. You'll need to either overhaul or replace it.

**5. Check the condition of the rubber boot** in the caliper if the car has disc brakes. (See Section 40, *Replacing Worn Disc-Brake Pads*, page 222.)

**6. Remove the vacuum hose from the brake-assist unit.** Twist the shank of a screwdriver inside the hose. If there is brake fluid on the screwdriver, it indicates that the seals have failed. Replace the master cylinder.

Also, disassemble the brake-assist unit and clean rubber parts with alcohol. Failure to do this will result in deterioration of these rubber parts.

If everything checks out okay to this point, an undetectable leak may exist in the master cylinder. Fluid may be leaking past a defective secondary cup into the cylinder boot. Disassemble the cylinder to see if a leak exists. If you do find one, replace the master cylinder.

**Inspecting brake linings**

Check brake-pad thickness. If it is  $\frac{1}{16}$  in. or less, replace the pads. To check brake-lining thickness of drum brakes, remove a front brake drum, if the car is equipped with drum brakes on all four wheels. If the car has drum brakes only on rear wheels, remove a rear brake drum.

Measure brake-lining thickness at several points. Replace lining if thickness is  $\frac{1}{16}$  in., or less, at any point. Be sure to replace the linings of both wheels on the same axle to attain equal braking action. **FM**

## 39. Road-testing brakes

**T**o road-test your brakes properly, find a dry, smooth and level road that has little or no traffic. Make sure that tires are inflated to proper specification. Improperly inflated tires can cause conditions resembling problems due to brake malfunctions.

While doing this test, keep aware of brake-pedal fade, characterized by the brake pedal falling away under pressure. When excessive heat is applied to brake linings, they lose their ability to hold against brake drums or discs.

A lot of heat will be created as testing is done. If the pedal should fade away, stop testing, pull off the road and let the brakes cool at least 10 minutes.

**The road test**

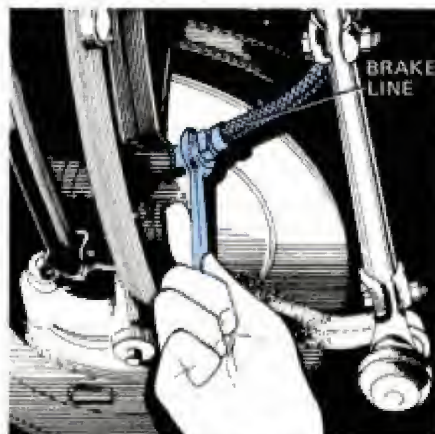
Drive between 10 and 15 mph. Make a few stops, alternately applying light and medium pressure to the brake pedal. Come to a full halt every time you apply the brake. Go through this checklist.

- Do brakes grab?
- Do wheels pull to one side?
- Is extra effort needed to stop?

If the car pulls to one side, check for uneven tire-tread wear, loose or worn wheel bearings, loose steering and improper front-wheel alignment before overhauling the brake system.

At all times when you test brakes, listen for squealing, clicking or scraping as you apply the pedal. These noises signify brake trouble.

Accelerate the car to 55 mph and make several normal stops. Do brakes chatter or



**Replace brake hoses that are soft, weak, bulging, collapsed or otherwise damaged.**

shudder? If so, check wheel-bearing condition. If bearings are okay, suspect brake discs or drums, which may be out-of-round.

At 55 mph, make a couple of hard stops, but not hard enough to cause a skid. Come to a halt each time, and drive at least two miles before making the test again to avoid high temperature buildup which could occur in pads and linings.

Listen for noise and determine if extra effort is needed to stop the car.

**Brake diagnosis**

The following chart lists problems that you may encounter during road and stationary tests:

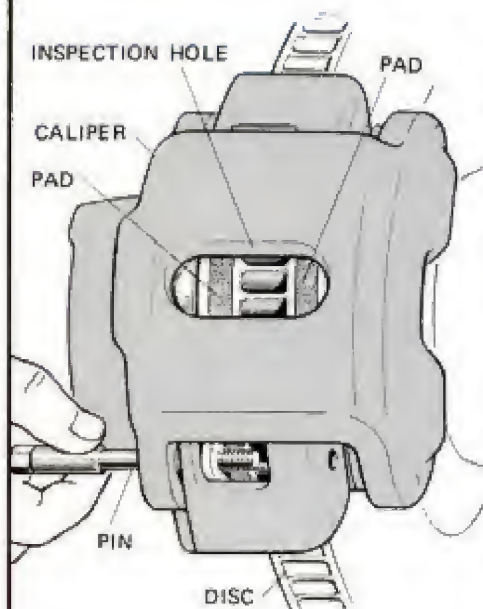
Problem	Causes (see footnotes)
Low brake pedal (excessive pedal travel needed to apply brakes).	A B C D
Spongy pedal.	C D E F
Hard pedal (excessive pressure needed to stop car).	A B D F
Fading pedal (pedal falls away when brakes are cool).	C D E F H
Brakes grab or pull.	B C F G H I J
Brake noise.	A B C G K
Chatter or shudder.	B C G I
Brake drag.	A B D F G H K L

**Footnotes**

- A. Brake shoes improperly adjusted; self-adjusting mechanism frozen.
- B. Worn, contaminated or distorted brake linings.
- C. Cracked, thin, scored or out-of-round drums or discs.
- D. Damaged master cylinder.
- E. Air in the hydraulic system.
- F. Brake hose or lines damaged (kinked, dented, loosely connected).
- G. Brake packing plate rusted, loose or worn.
- H. Damaged wheel cylinder.
- I. Loose or damaged wheel bearings.
- J. Front wheels not aligned or uneven tire tread.
- K. Weak or broken brake-shoe return spring.
- L. Parking brake improperly adjusted or dragging.



# 40. Replacing brake pads



**R**eplace disc-brake pads (linings) before they wear badly enough to cause scraping noises when brakes are applied. A scraping noise indicates that the pads have worn and the metal shoes which support the pads are rubbing against the metal discs.

Inspect pads by removing one of the front wheels at 12,000-mile intervals. Examine the pads through an inspection hole. If there is one. If not, remove the pad and measure lining. It should be at least  $\frac{1}{16}$  inch thick.

The following will serve as a guide to replacing most domestic disc-brake pads.

**1. Examine the caliper** for guide pins that hold pads in place.

**2. Remove locking clips** from guide pins. Pull guide pins out.

**3. Does the installation use an antirattle spring?** If so, remove it.

**4. Grab pads and slide them straight out of the caliper.** If this is dif-

*To release disc-brake pads, remove the locking clips and pull out the guide pins.*

ficult to do, fashion a hook from a metal coat hanger, hook guide pinholes and pull out pad.

**5. Examine the boot** surrounding the piston in the caliper for fluid leakage. If fluid is present, remove and overhaul the caliper.

**6. Wrap a rag around the shank of a screwdriver.** Place this against the piston and push the piston back into the bore.

**7. Slide new pads into the caliper.** Reinstall the antirattle spring, if one is used, and reinsert guide pins and locking clips.

Some pistons can't be moved back into the caliper with the force exerted from a screwdriver. If you try it and it does not work, don't force it. Use a C-clamp instead.

Engage the outer jaw of the C-clamp over the piston and the inner jaw on the caliper. Tighten the clamp slowly. If the piston still doesn't move, it may be frozen. The entire caliper must be overhauled.

Before pushing the piston out of the way, take the cover off the main brake-fluid reservoir and use a clean rag to catch any fluid that may be forced out.

PM

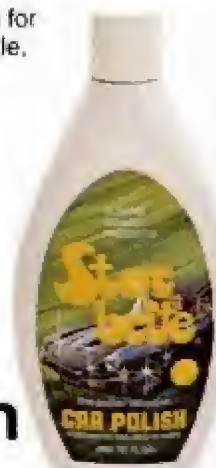
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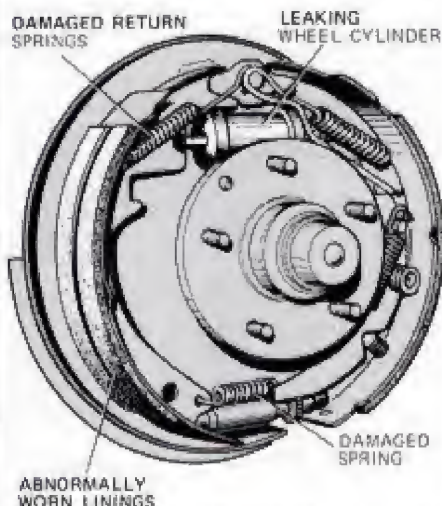
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# CAR CARE GUIDE 1980

## 41. Replacing drum-brake lining



When inspecting drum brakes, examine these areas for a malfunction or damage.

The following points apply to the overhaul of most drum-brake systems:

1. **Disconnect brake lines** at wheel cylinders; tape openings to keep out dirt.
2. **Overhaul cylinders with rebuild kit.** Remove end boots. Press out pistons, cups and expanders. Clean metal parts in brake fluid or alcohol. If cylinder inside is scratched, replace cylinder. Before inserting parts in cylinder, coat with clean brake fluid.
3. **Check brake linings** for abnormal wear indicating brake-drum damage. If lining is worn more on one side, drum is tapered. Wear at toe or heel suggests out-of-round.
4. **Clean drums,** if they are in good shape, by removing deposits with stiff brush. Use non-oil base solvent.
5. **Discard a cracked drum.** Surface defects may be removed by turning drum on a lathe. After cutting drum, check metal thickness to make sure it does not exceed standard stamped on it.
6. **Match new linings** by grinding them to match measurement of drum taken with a micrometer. This assures that linings make full contact with drum. Partial contact causes less efficient braking and premature wear.
7. **Examine brake-shoe return springs.** Replace any that are damaged.
8. **Inspect backing plate** for rust and dirt. Remove rust with emery cloth.
9. **Adjust brake shoes before installing drums.** Use brake-shoe adjusting gauge. Set it to the inside diameter of drum; tighten lock screw. Turn gauge around and fit it over brake shoes. Expand shoes by manually turning self-adjusting-mechanism star wheel until gauge just slides over linings. Move gauge over entire lining surface to assure correct clearance from heel to toe.
10. **Fill the master cylinder** and bleed the system.

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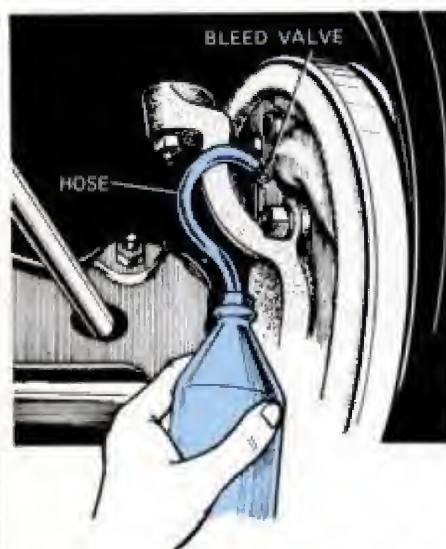
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# 42. Bleeding brakes



On drum brakes, bleed valves are located on the back of each wheel. On disc brakes they're found on top of caliper.

**T**o bleed brakes, you need the appropriate wrench, brake fluid, a clean receptacle, a vacuum hose and an assistant to press the brake pedal as you bleed each wheel.

Brakes on some cars cannot be bled as described here. A process called power bleeding, using special equipment, is required. Check your manual to see if your car falls into this category.

**1. Pump the brake pedal 10 times,** with the engine turned off, to dissipate vacuum in the booster unit, if your car has vacuum-assist brakes.

**2. Raise and support the car.**

**3. Engage the bleed valve with a box wrench.** Attach the vacuum hose to the valve and place the other end in the receptacle, which should be filled about halfway with clean brake fluid. Then open the bleed valve three-quarters of a turn. Let the person in the car apply the brake pedal, slowly but steadily. When the pedal hits the floor, tighten the valve. The pedal will return to normal position. Repeat, until no more air bubbles appear in the fluid.

**4. Refill the reservoir to within 1/4**

**inch of the top** with fresh brake fluid when level falls about halfway. You might have to do this more than once.

**5. Start the engine and pump the brake pedal** a few times when bleeding is finished. Make sure you have a firm pedal. If not, repeat.

If the master cylinder has a bleed valve, begin the bleeding here. Then go on to each wheel. The recommended wheel sequence for bleeding brakes is:

■ AMC, Chrysler and Ford: Right rear, left rear, right front, left front.

■ General Motors (except Chevrolet): Left front, right front, left rear, right rear.

■ Chevrolet: Left rear, right rear, left front, right front.

When you complete bleeding, the brake warning light on the dashboard will probably be lit. Turn the ignition switch to ON or ACC position and apply the brake pedal once. If the light doesn't go off, you have a model that requires centering the light switch inside the brake-metering valve housing. Never disconnect the switch; the warning system won't work if there's a brake failure.

PM

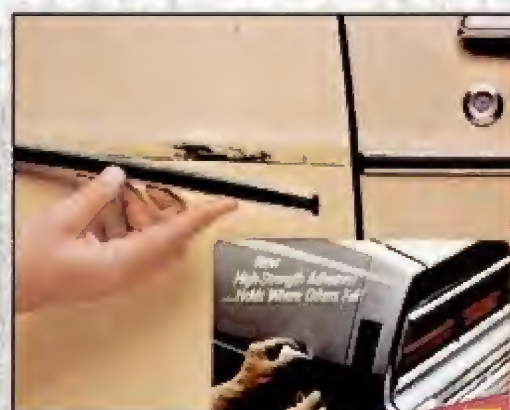
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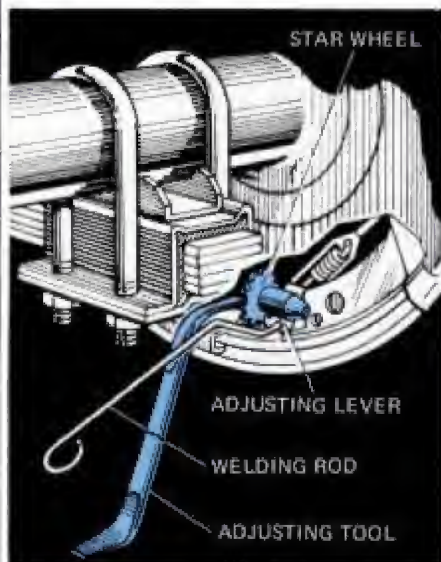


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## 43. Adjusting drum brakes



Adjust drum brakes by turning the star wheel with the brake-adjusting tool.

**D**rum brakes are adjusted in two ways—automatically and manually. Automatic adjustment is done whenever you back up the car, by means of self-adjusting mechanisms. Manual adjustment has to be done after drum-brake overhaul.

### Automatic adjustment

If the brake pedal is too low, find a deserted road and back up about 200 feet. Stop the car. Drive forward about 200 feet. Back up again. Do this several times.

The brake pedal should come up. If it doesn't, the self-adjusting mechanisms may be frozen or damaged and require repair. However, there may be another problem. For example, worn brake linings prevent a high brake pedal.

### Manual adjustment

Raise and support the car. Find the adjusting slot. It is either in the backing plate (rear) or in the brake-drum flange (front). Insert the brake-adjusting tool into the adjusting slot and engage the adjusting star wheel.

Raise the handle of the tool, turning the star wheel up. This moves the brake linings against the brake drum. At the same time, rotate the brake drum by hand. Keep doing this until the brake drum locks.

Now, move the adjusting spoon down, so the star wheel is turned in the opposite direction. Keep rotating the brake drum. Adjust the star wheel until the brake drum rotates freely.

If the adjusting slot is in the brake-drum flange, the adjustment is done the same way, but with one exception. Move the adjusting spoon down until the brake linings are against the brake drum, locking the drum. Then move the adjusting spoon up to back the linings off the drum until the drum rotates freely.

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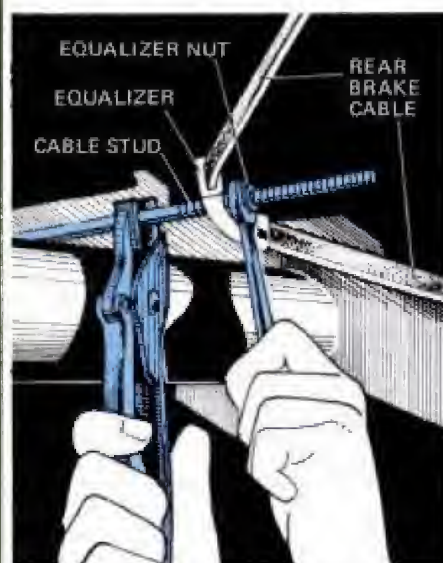
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## CAR CARE GUIDE 1980

### 44. Adjusting parking brakes

**A**s the parking-brake cable is used over a period of time, it will stretch. You can tell if the cable has stretched too far by counting the number of clicks it takes until the brake engages. If there are six or more clicks, the parking brake needs adjusting.

1. **Engage the parking brake** until it clicks once.
2. **Raise and support the car.**
3. **Inspect the cable** for frayed and crimped areas. If the cable is damaged, replace it.
4. **Examine the adjusting mechanism.** If it is rusted, apply penetrating oil.
5. **Spread white lithium grease** on all the friction surfaces and along the cable itself. This keeps the cable from binding. A cable that binds can cause rear brake linings to scrape against rear brake drums, leading to premature brake wear.
6. **Tighten the adjusting nut** a little



*To adjust brake, grasp rod and turn adjusting nut. Grease all fittings and cable.*

at a time as you turn a rear wheel. Stop turning the adjusting nut when the rear wheel just begins to drag. Release the parking brake from inside the car and, again, turn the rear wheel. There should be no drag. If there is, back off the adjusting nut until the drag disappears.

#### Adjusting mechanisms

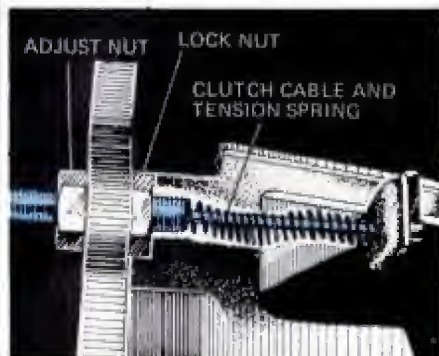
Various setups are used. For example, on some cars with bucket seats, the adjusting nut is inside the car at the base of the parking-brake handle. To reach it, you have to unscrew or pry off the rubber dust boot.

On some cars made by Chrysler, the adjusting nut is positioned at the end of a steel housing. Volkswagens have two adjusting nuts, one for each rear wheel. Both have to be adjusted.

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## 45. Adjusting clutch



Typical AMC clutch uses an adjusting nut and a locknut. Free play desired is 1½ in.

The following describes various clutch-adjustment procedures recommended by manufacturers.

Some models may deviate from the methods described here. However, the free-play adjustments apply to most models made by the manufacturer.

**1. American Motors:** Loosen the locknut and turn the adjusting nut to shorten the length of the threaded rod until the specified clutch-pedal free play is attained. AMC recommends that the pedal have a free play of ¾ to 1½ in., but the latter is preferred. Tighten the locknut.

**2. Chrysler:** Turn the adjusting nut so that the clutch fork moves forward as you measure the clutch-pedal free play. When the pedal has 1 in. of free play, stop turning the nut.

**3. Ford:** Unhook the tension spring between the clutch fork and adjuster. Loosen the locknut and adjusting nut. Push the operating rod and clutch fork back until you feel resistance. Then use a feeler gauge to set the adjusting nut and locknut 0.2 in. from the sleeve. Attach the tension spring. Check for length of pedal travel, which should be 1 in. while the engine is turning over at a fast idle.

**4. General Motors:** Unhook the tension spring and loosen the locknut. Screw the operating rod in place. When 1 in. of clutch-pedal free play has been attained, tighten the locknut and attach the tension spring.

**5. Volkswagen:** Raise the rear of the car. Remove the left rear wheel and heater hose. Reach up and grasp the clutch cable with pliers to keep the cable from twisting. Reach up with your other hand and loosen the wingnut and the clutch lever. Pedal free play should range between ¾ and 1 in. After making the adjustment, rotate the wingnut to the horizontal position so that it engages the lever and locks in place.

**6. Other imported cars:** Generally, imported cars have a locknut and adjusting nut at the clutch fork. Loosen the locknut and turn the adjusting nut until the specified clutch play is attained.

FM

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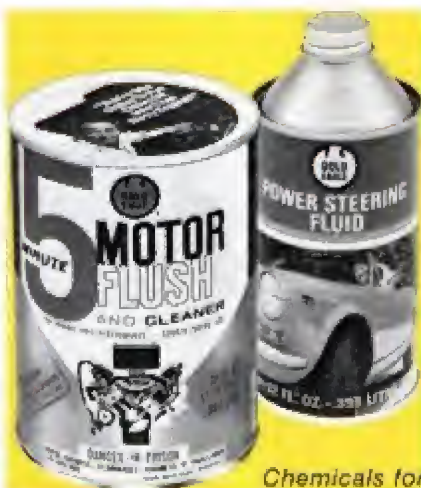
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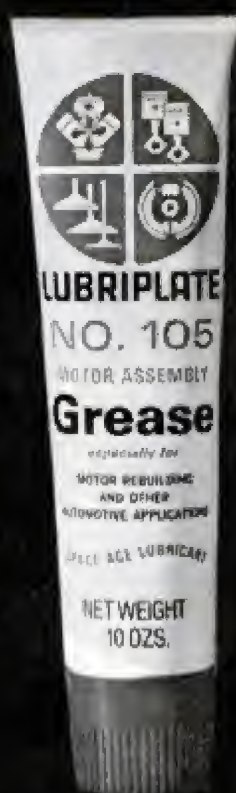
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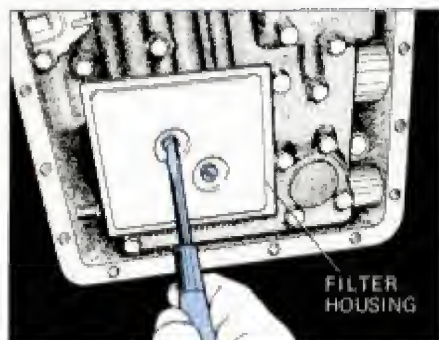


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# 46. Servicing transmission



When replacing transmission fluid, always be sure to service the transmission filter.

**S**ervicing an automatic transmission involves checking fluid level every three months and replacing fluid and filter every two years or 24,000 miles, whichever comes first.

### Checking fluid level

1. Warm up the engine to normal operating temperature.
2. Park the car on level ground and engage the parking brake.
3. Place the transmission selec-

tor lever in **NEUTRAL** if the car is an AMC or Chrysler. If the car is a Ford or GM model, set the transmission selector lever in **PARK**. For other makes, consult the owner manual.

4. Find the **transmission-fluid dipstick**, which is at the rear of the engine at the transmission. In some models, the oil dipstick is in the same area, so don't confuse the two.

5. Wipe the area around the **dipstick** with a cloth to remove dirt that may get on the dipstick and be transferred to the fluid. Be careful not to introduce dirt into the transmission.

6. Pull the dipstick from the tube and wipe it off with a clean cloth. Reinsert the dipstick and withdraw it again. Check the level.

7. Add fluid, if needed, but do not fill the transmission so the fluid level goes above the **FULL** mark on the dipstick. Use a clean funnel in the dipstick tube when pouring fluid into the transmission.

### Replacing fluid

When the time comes to replace fluid, raise and support the car. Look for a drain plug on the transmission pan. If there is a plug, remove it and allow transmission fluid

to drain. Remove the pan to replace or clean the filter.

If there is no plug, start at one end and loosen (don't remove) transmission oil-pan bolts. When the last bolt has been loosened, pry the pan loose from the transmission housing with a putty knife and allow fluid to fall from the assembly. When fluid has finished draining, remove the pan.

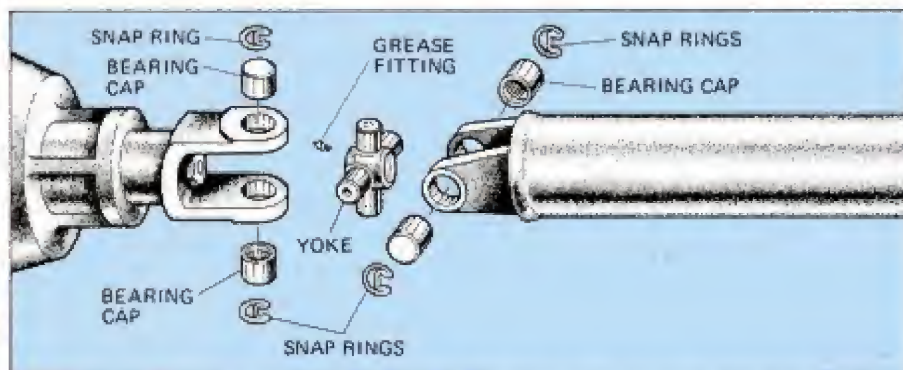
Find the filter or metal screen inside the transmission. It is held by screws or clips. Remove the filter or screen. Discard an old filter and install a new one. Clean a metal screen in naphtha. Let the screen dry and reinstall it.

Scrape old gasket material from the oil pan and wash the pan in solvent. Wipe it dry. Scrape old gasket material from the transmission housing. Wipe it clean. Use a putty knife or gasket scraper to remove the old gasket. Do not use a screwdriver or chisel.

Apply a thin coat of white grease to the transmission pan and lay a new gasket in place on the pan. The grease will hold the gasket in place as you install the pan.

Reattach the pan to the transmission housing and insert the bolts. Tighten the bolts in a crisscross sequence. Pour in new fluid and check around the pan for leaks. **FM**

# 47. Replacing U-joints



When universal joints begin to fail, they create noise and vibration, which are warnings of danger. Replace the entire unit, using a new cross assembly and caps.

**I**f a universal joint fails, there is danger that the driveshaft may fail as the car is being driven. Luckily, a bad U-joint usually makes noise before this happens, warning you of impending danger.

To test for a loose U-joint, grasp the driveshaft near each U-joint and try rocking the shaft back and forth. There should be no play. If there is play, replace the U-joint.

### Replacing a U-joint

1. Lift and support the car.

2. Remove U-joint flange bolts at the rear U-joint.

3. Scribe a mark across the shaft yoke and differential flange before removing the driveshaft. This mark allows you to realign the driveshaft properly.

4. Drop the rear of the driveshaft until it clears the differential and pull the shaft toward the rear.

5. Prop the driveshaft on supports and place the end of the shaft having the bad U-joint in a vise.

6. Remove caps of U-joints by encircling them with a piece of pipe that has a diameter large enough to fit the caps. Strike the end of the pipe with a hammer to break the cap retainer loose and to force the retainer and cap from the U-joint yoke. Turn the driveshaft around and do the same thing to the opposite cap.

Remove other types of U-joints by pulling loose the snap-ring retainer. Tap around the circumference of the cap with a hammer until the cap pops loose and slide the U-joint assembly from the shaft yoke.

7. To install the new U-joint, install the cross assembly in the shaft yoke, press on bearing caps and tap the caps into place.

8. Reinstall the driveshaft.

### Constant-velocity joints

CV joints are found in front-wheel-drive cars and usually last the life of the vehicle. However, they do need to be serviced periodically.

1. Inspect the rubber boot around the joint for cuts, cracks or loose circlips.

2. Remove the boot and inspect the CV joint. If the joint has thrown off all its packing grease, repack it with molybdenum grease and replace the boot. **FM**



## BODY SERVICE

### 48. Repairing body dents



A slide hammer is an indispensable tool for pulling out any dents in body panels.

**R**epairing body dents can be a fairly easy procedure if you use the right tools. All the necessary tools and supplies are available in most auto parts stores.

#### Repairing a dent

**1. Punch a hole in the dent with an awl.** If the dent is large, you should punch several holes, but be sure that they are at least 1 in. apart.

**2. Insert the slide hammer in the hole** and slam the slide against the hammer handle to pull out the dent.

**3. Grind the surface down to bare metal,** using a body-grinding disc in an electric drill.

**4. Mix plastic body filler and hardener** and apply the compound in thin coats. Build up the filler to about 1/4 in. above the metal surface.

You should allow the filler to set for at least 15 minutes.

**5. Mold the filler to the shape of the metal** with a "cheese grater" file and allow the compound to harden completely.

**6. Sand the area with 40-grit sandpaper** in a block until it is smooth. Follow this by sanding with 100-grit sandpaper and bring the filler down flush with the level of the metal.

**7. Feather the edges of the repair** with 200-grit, wet-or-dry sandpaper. Don't use a sanding block for this operation. Keep the sandpaper wet.

**8. Apply a thin coat of primer to the repair** after covering trim areas that might be hit by paint spray. Let the primer dry.

**9. Apply a thin coat of auto glazing compound** to fill the imperfections left by the sandpaper.

**10. Sand the area again,** using a piece of 320-grit, wet-or-dry sandpaper attached to a sanding block. Sand the area lightly until the surface finish is smooth and free of high spots or ripples.

**11. Apply another coat of primer paint** and let it dry thoroughly. Paint the repair area with the finish coat, allow it to dry and paint again.

In order to bring out the gloss, use rubbing compound several days after the finish coat has dried.

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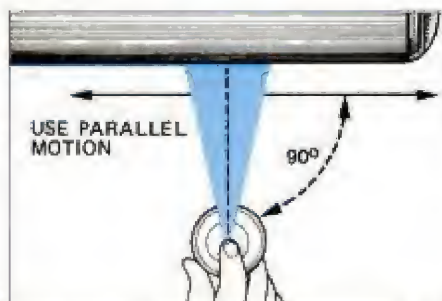
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# 49. Touching up paint



Use even, rapid strokes when spraying the paint. Keep the can parallel to the surface you are painting and apply the spray in light coats to avoid any sags and runs in the paint.

**B**efore choosing a matching-color, touch-up paint, check the vehicle identification plate, which is attached to the door pillar or firewall of your car. A designation on the plate will indicate the original paint color code.

If you've never used spray paint before, practice the technique on a piece of scrap

metal or a tin can. The following tips will help make the job a success:

- Follow instructions on the can.
- Shake the can for at least a minute before you start to paint; shake often as you paint.
- As you spray, keep the can moving. Spraying without moving the can causes paint to run.

■ Move the spray can fairly rapidly. A slow motion causes paint to build up and run.

■ Keep the can parallel to the surface you're painting. Avoid sweeping motions that cause the distance between the can and surface to vary. Keeping the can parallel allows paint to be applied in a uniform layer. Varying the distance causes paint to be heavier in some spots than others.

■ Spray the surface using light coats; apply a thin coat, wait 30 to 60 seconds, apply another thin coat, and so forth. Applying the paint heavily causes it to sag.

■ If you are touching up a relatively small area, such as a scratch, cut a hole in a piece of cardboard. Hold the cardboard about 12 in. from the surface and aim the spray through the hole. Using this technique allows you to get smooth edges between new and old paint.

■ Let paint dry for about a week. Then, with a wet rag, rub the painted surface lightly with rubbing compound. Stop rubbing when the new paint and old paint blend together. **PM**

# 50. Servicing weatherstripping

**W**ater that leaks into a car is not difficult to stop. Most leaks have their source at the windshield and backlight. Backlight is the technical term for the rear window. When a leak appears on the floor in the front of the car, test the windshield first. When a leak appears in the rear of the car, test the backlight first.

## Detecting a leak

Tape a garden hose, minus nozzle, to the roof of the car so that water that comes from the hose flows over the windshield or backlight. Place a small can in front of the hose outlet to disperse water coming from the hose. The object of this is to have water spread out to cover the entire glass area.

Turn on the hose and check to make sure the entire windshield or backlight surface is being covered by water. If not, readjust the tin can and hose. Now, watch the area inside the car where you saw the water that made you suspect a leak in the first place. And wait. You may, in fact, have to wait for as long as 30 minutes before a leak, if there is one, shows up.

Every 10 minutes or so, rock the car from side to side. This permits water, which may collect in a seam, to be freed. Sometimes water that collects in a seam leaks into a car

only when the car turns corners. Rocking the car simulates turns. If water appears inside the car, it confirms the fact that it's entering through the windshield or backlight. Seal the glass.

## Sealing leaks

**1. Remove molding strips,** using a molding-trim tool. You can purchase this tool at a store that sells auto-body equipment or at an auto-glass shop.

Slide the tool between the glass and chrome strip until it strikes a clip. Then twist the tool to pop the molding off the clip.

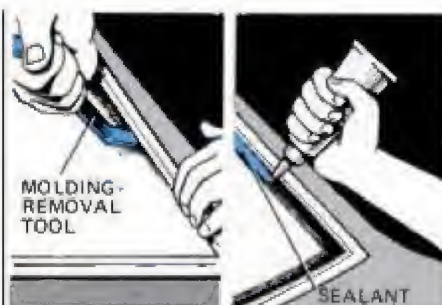
**Caution:** An attempt to remove molding with any other tool may result in cracking the glass.

**2. Mark the location of clips; then remove them.**

**3. Take a clip to an auto-body store or glass shop and get new clips.** Old clips should not be reused because, more than likely, they will be twisted out of shape when the molding is removed.

**4. Install new clips.**

**5. Apply auto windshield sealer,** as directed on the tube. Make sure the sealer covers every inch of the edge around the glass. A gap leaves a potential area for water leakage.



To seal a windshield leak, remove molding with tool and apply rubber-based sealer.

**6. Place molding strips back in place** over the edges of the glass and push them back onto the clips.

## Other areas of leakage

If water is not leaking through the windshield or backlight, it may be entering the car through such areas as windshield-pillar (A-post) seams, windshield-wiper bosses, hood-drip grooves, holes in the firewall, seams around the drip rails and the fender seams.

With someone inside the car, play a steady stream of water, under maximum pressure, on each suspected area for several minutes. Water entering the car reveals the source of the leak, which can then be sealed with an auto-body sealing compound.

If water is leaking into the trunk, check the condition of the gasket by having an assistant in the trunk as you play water along trunk seams. Armed with a flashlight, he'll be able to pinpoint the source of the leak. The gasket can then be shifted or, if it's damaged, replaced. **PM**



# CAR CARE GUIDE 1980

## Recalls

One year ago, Car Care Guide published a list of AMC, Chrysler, Ford and GM cars involved in safety-related recall campaigns. It covered the years 1966 through 1977 and part of 1978. The report below brings recalls up to date—all those announced in 1978 and some in 1979. The final 1979 report had not been completed by the National Highway Traffic Safety Administration at preparation time.

Recalls reported are those involving more than 800 vehicles. If your car is listed and you haven't had the modification applied, take the car to a dealer. If you bought it used and don't know if the repairs have been made, write the manufacturer. Provide the vehicle identification number. The maker can check files to determine if the work has been done. A dealer should be able to tell by inspecting the car.

If you need more information about a recall, or want to report what you believe is a safety hazard with a vehicle or related component, call the NHTSA Auto Safety Hotline. The toll-free number is 800-424-9393.

### AMERICAN MOTORS CORP.

Year/Model Cars Involved	Description of Defect Corrective Action
1974-76: 471,333 Gremlin, Hornet, Pacer, Matador.	Two-wire ignition connector may fail; stop ignition; cause hesitation, stalling. Get new connector.
1975-76: 102,398 Jeep CJ5, CJ6, CJ7, Cherokee, Wagoneer.	Two-wire ignition connector may fail; stop ignition; cause hesitation, stalling. Get new connector.
1975-76: 133,593 Gremlin, Hornet with power steering.	Power-steering may be too near exhaust manifold; cause hose rolling, power-steering loss. Reroute hose.
1975-76: 96,933 Jeep CJ5 and CJ7 with 3-speed manual transmission.	Moving of lubricant from transmission to transfer case may cause inoperative transmission. Reposition rear oil seal.
1976: 9650 Pacer.	May have deficient lower-control-arm ball-joint assembly. Replace both lower-control-arm ball joints.
1976: 1995 Jeep Cherokee and truck.	Throttle may not close fast enough under extreme conditions, may cause loss of control. Add a spring to accelerator control system.
1976: 2726 Jeep CJ5 with manual steering.	Coupling attaching intermediate shaft to steering gear may have oversize serrations that could keep it from being properly tightened on steering-gear shaft, affecting steering. Replace coupling.
1979: 1170. Jeep CJ5, CJ7 with 3- and 5-speed transmission.	Incorrect gasket may be between transmission and transfer case, interfere with normal lubricant flow, damage transmission. Replace.
1979: 7700 Concord Six wagon.	Incorrect data on tire air-pressure placard. Install new placard.

### CHRYSLER CORP.

1975-77: 370,000 Fury, Gran Fury, Comet, Charger, Cordoba, Monaco, Royal Monaco.	Carburetor accelerator-pump seal distortion may cause persistent hesitation or stalling. Also, premature activation of EGR system may cause cold-engine hesitation or stalling. Replace accelerator pump; modify EGR system.
1976-78: 1,106,000 Volare, Aspen.	Front-suspension pivot-bar support plates may fail, affect vehicle control. Install reinforcing brackets on the support plates.
1978: 36,000 Horizon, Omni.	Fuel tank may leak when full, because rear-floor carpet fasteners may have punctured tank top. Replace fuel tank, if necessary.
1978: 15,000 Colt, Challenger, Arrow, Sapporo	Fuel may leak out fuel pump into engine compartment. Replace pump.

(Please turn to page 232)

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## RECALLS (Continued from page 231)

Year/Model Cars Involved	Description of Defect Corrective Action
1978: 31,000 Horizon, Omni.	May have improper lower-steering-shaft coupling, causing excessive free play, loss of steering. <i>Replace</i> .
1978: 42,000 Horizon, Omni.	Front-suspension control arm to ball-joint rivet attachments may be too weak for high impacts, lose control. <i>Reinforce with bolt, nut</i> .
1978: 14,000 Horizon, Omni with airconditioning.	Airconditioning suction hose may abrade fuel hose, causing a hole and fuel leak. <i>Reroute hoses</i> .

### FORD MOTOR CO.

1971-72: 82,200 Capri.	Headlamp switch failure may cause loss of lights. <i>Replace switch</i> .
1971-73: (Number not available; all cars re- called) Capri.	Reclining mechanism failure may let seat rotate to rear, causing driver to lose control. <i>Modify</i> .
1971-73: 187,000 Capri.	Windshield-wiper adapter arm may separate from pivot shaft without warning, making wipers inoperative. <i>Replace wiper pivots</i> .
1971-78: 1,400,000 Pinto, Bobcat except station wagons.	Fuel tanks and filler neck may fail in rear collision, causing leakage, fire. <i>Replace fuel filler pipe and seal; install shield</i> .
1974: 60,000 Pinto, Mustang II with manual steering.	Inadequate clamping of steering-coupling flange on steering-gear input shaft may cause failure, loss of steering. <i>Replace flange, bolt</i> .
1974, 76, 77: 10,000 Capri, Capri II with airconditioning.	Airconditioning blower-motor resistors may cause overheated housing, lead to fire. <i>Replace assembly</i> .
1976: 284,000 Pinto, Bobcat.	Car may fail 30-mph barrier impact test, cause fuel leak in engine compartment. <i>Install front-bumper bracket extension plates</i> .
1976-77: 120,000 Granada, Monarch.	Seven-blade fan may separate in fragments without warning—a threat to anyone nearby. <i>Replace</i> .
1978: 185,000 Fairmont, Zephyr.	Main wiring assembly may chafe on cowl-to-brake pedal-support brace, cause wires to ground, lead

	to partial or total power loss. <i>Install shield on support brace</i> .
1978: 1956 Mustang, Bobcat.	Automatic rear seat-belt retractors may not lock on impact. <i>Replace</i> .
1978: 110,000 Thunderbird, Ford 4- doors and wagon, LTD II 4-doors, Cou- gar.	Front outboard seat-belt-assembly shoulder harness may not lock on impact. <i>Replace</i> .
1978: 400,000 Fairmont, Zephyr.	Windshield-wiper drive linkage may fracture, making wipers inoperative. <i>Replace linkage</i> .
1978: 218,000 Fairmont, Zephyr with 200-cu.-in. engine, automatic trans. and Thermactor pulse air- supply system.	Air reed valve for airflow from air cleaner to exhaust manifold may fail, cause rich fuel mixture leading to reduced engine performance. Continued use can cause stalling or overheated exhaust system which may scorch rear seats and carpets, produce fumes. <i>Replace valve</i> .
1978: 18,000 Fiesta.	Mislocated valve-stem holes may lower tire pressure at high speed, causing steering pull, tire overheating or failure. <i>Replace wheel</i> .
1979: 5000 Ford, Mercury.	A 8-amp. circuit breaker (rather than 8.25-amp.) in the windshield wiper-washer system may fail under heavy load. <i>Use right breaker</i> .
1979: 8700 Ford, Mercury.	Front-brake hose may chafe on edges of frame-mounted rebound bumper brackets; resulting wear can cause loss of brake fluid and brakes to fail. <i>Install protective material on edges of these brackets</i> .
1979: 20,000 Ford, Mercury.	Wrong rear-lamp sockets. <i>Replace</i> .
1979: 32,350 Mustang, Capri, LTD with 5-liter (302-cu.- in.) engine.	Engine cooling fan may separate in fragments without warning—a threat to anyone nearby. <i>Replace</i> .
1979: 4000 LTD II, Ranchero, Thunderbird, Cougar XR7.	Stripped rear-outboard-seat track to floor-pan weld nuts may cause seat to fly loose in collision. <i>Retorque if possible, or replace nuts</i> .
1979: 25,453 LTD.	The word LIGHT is omitted on instrument panel. <i>Affix label</i> .

1979: 9500 Fairmont, Zephyr.	Weight certification labels may be wrong. <i>Install proper label</i> .
1979: 16,000 Mustang, Capri.	Wrong steering-gear coupling flange may slip. <i>Replace</i> .
1979: 2700 Mustang, Capri.	Plastic fan guard may be struck by fan and fracture, injuring someone nearby. <i>Install guard supports</i> .
1979: 162,000 LTD, Marquis.	Chafing of front brake hoses may cause fluid loss and brake failure. <i>Provide clearance between hoses and fully turned wheels</i> .
1979: 82,000 LTD II, Fairmont, Thunderbird, Mus- tang, Granada Ver- sailes, Mark V, Con- tinental, Zephyr, Capri, Cougar XR7, Marquis, Monarch, Econoline, F-series light trucks, Bronco.	Defective brake pushrod to brake-pedal retaining pin may cause loss of brakes. <i>Replace retaining pin</i> .

### GENERAL MOTORS

1959-60: 22,353 Cadillac.	Pitman arm may separate, causing steering loss. <i>Replace</i> .
1975: 130,965 Starfire, Monza, Sky- hawk.	Excessive heat in wheel-bearing area may cut grease viscosity, causing front-wheel-bearing failure. <i>Install new grease retainers, seals</i> .
1976-77: 320,000 Chevette.	Vehicle fuel system may not meet federal safety standards for fuel-system integrity. <i>Install shields around front corners of fuel tank and larger washers on certain rear-suspension parts</i> .
1977-78: 388,867 Cadillac DeVille, Brougham, Limous- ine.	Fire from combustible materials accidentally ignited in ashtray may reach instrument-panel interior, be hard to put out. <i>Install heat shield</i> .
1977: 6155 Eldorado, Toronado.	Transmission PARK position pawl may not engage due to wrong return spring, letting car roll free. <i>Install correct spring assembly</i> .
1977-78: 172,000 Monza, Sunbird, Star- fire.	Hard bottoming may damage pitman arm or steering linkage, cause hard steering. <i>Reinforce the affected area</i> .

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hard to find. You may even have to ask your store manager to get it for you. But it's worth it. Because once you see the difference, you won't want to use anything else.



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1977-78: 372,466 DeVille, Brougham, carbureted engine.	Accelerator-pedal flap may get caught, causing high rate of speed. <i>Remove pedal flap.</i>
1977-79: 476,245 Impala and Caprice wagons, Safari wagon, Custom Cruiser, Estate Wagon.	Child may open, enter and be trapped in rear side storage compartment; door can't be opened from inside. <i>Replace with new latch, plus key to latch and lock.</i>
1978: 22,268 Monza, Sunbird, Starfire, Skyhawk, P30 Motorhome.	Wrongly machined steering intermediate shaft coupling may prevent proper tightening to steering-gear shaft, affecting steering. <i>Replace.</i>
1978: 1643 Malibu, Monte Carlo, LeMans, Grand LeMans, Grand Am.	Incorrect head restraint may have been installed. <i>Replace.</i>
1978: 333,619 Malibu, Monte Carlo, Catalina, Bonneville, LeMans, Firebird, 88, Cutlass, Omega, Regal, LeSabre, Electra, Century, Skylark, Sprint.	Fan-blade spider may break apart without warning, a threat to anyone working under the hood or standing nearby. <i>Replace fan.</i>
1978: 1400 Impala, Caprice Classic.	Front-seat adjuster assembly lock bars may not engage in accident. <i>Add a lock bar return spring.</i>
1978: 1,900,000 Chevrolet, Pontiac, Oldsmobile, Buick, GMC Caballero.	Wheel-bearing failure may result in loss of control. <i>Modify.</i>
1978: 41,500 Seville.	Fuel-feeder hose of electronic fuel-injection system may deteriorate and leak fuel. <i>Install new hose.</i>
1979: 1,300,000 Chevrolet, Pontiac, Oldsmobile, Buick, Cadillac.	Heads of seat-belt anchor bolts may break off. <i>Install new bolts.</i>
1979: 8534 Riviera.	Wrong color side marker lights may be installed. <i>Replace bulbs.</i>
1979: 4208. Skylark, Starfire, H-special Monza, Sunbird.	Wrong oil-pressure switch may cause engine self-starting. <i>Replace switch.</i>
1979: 42,977 Skyhawk, Starfire, Sunbird, Monza with 231-cu.-in. V6.	Improperly positioned carburetor fuel-feed hose may rupture fuel leak. <i>Replace and reposition hose.</i>

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Roger Staubach,  
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**"The grip is basic for proper control"**  
Tom Watson,  
1977 Masters and  
British Open Champion

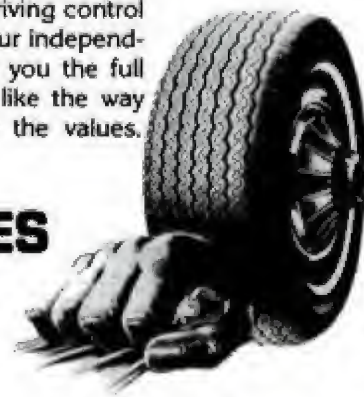
## "The grip is basic for proper control"

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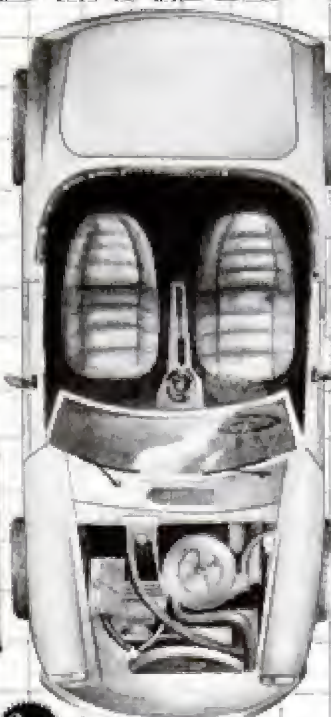
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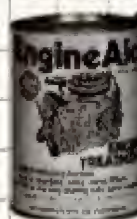
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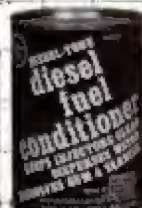
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Your home is a haven of peace and quiet, right? Wrong. You come home after a hard day at work, eager for rest and relaxation, and what do you find? Rock music blaring from the radio, a space war on TV, pots clanking in the kitchen, the shrieks of children at play, the whirl and rumble of endless machines.

The sounds are different at different times and in different households, but they all add up to one thing—noise. You can't escape it; it's all around you. It disturbs your rest, jars your nerves, makes you tense and tired and, according to medical studies, can actually endanger your health (see report on page 238).

### Our noisy lifestyle

Today, the mounting din of our modern, mechanized way of life is making the problem of noise more serious than ever. Experts estimate that the general level of noise in our environment is rising at the ominous rate of one decibel every year. This may not sound like much until you realize that the decibel scale is *logarithmic*, not arithmetic—a small jump in number can represent a very large jump in actual volume. A rise of only 10 decibels (db) amounts to a 100-percent increase or a *doubling* of sound intensity. At 1 db a year, the level of sound around us can double in only 10 years' time.

Fortunately, there are many things you can do to have a quieter home, most of which need not be expensive. There are valuable bonuses, too—soundproofing a house can also improve its appearance, increase its resale value and make it more energy-efficient. All of the measures discussed here can be applied in an existing structure. They were compiled by the National Bureau of Standards.

For health and comfort purposes, sound is usually measured on the so-called A-scale (dba), which is specially weighted to take into account the fact that the ear is more sensitive to some frequencies than others. The table on page 237 shows how typical sounds compare in intensity on this scale. Bear in mind its logarithmic progression: 70 dba is twice as loud as 60 dba, four times as loud as 50 dba, eight times as loud as 40 dba, and so on. Noise multiplies fast.

Potentially harmful levels of sound are believed to start at 75 to 80 dba. Common

PM's guide to  
peace and quiet:

# How to hush a noisy house

Today's mechanized home is getting noisier every day. You can't stop most sounds, but you can control them.

by Sheldon M. Gallager

household appliances—dishwashers, clothes washers and garbage disposers—typically operate in this range, though we can be thankful they run only for short periods. Peak kitchen noise can reach 90 dba; a table saw, 100 dba; loud

rock music, as much as 120 dba—right up at the level of physical discomfort to your ears.

We may not be able to eliminate noise at its source, but we can do a lot to keep it from traveling. The noisiest spots in a home are usually the kitchen, bathroom, playroom or family room, and furnace/shop/utility area. These, however, are not necessarily the places where you want or need the most peace. It may be equally important to quiet adjacent areas—say, a bedroom next to a bath, a study over a playroom, a living room near a kitchen. You have to decide whether you want to keep noise *down* in one room or *out* of another room. The techniques of doing the two are different.

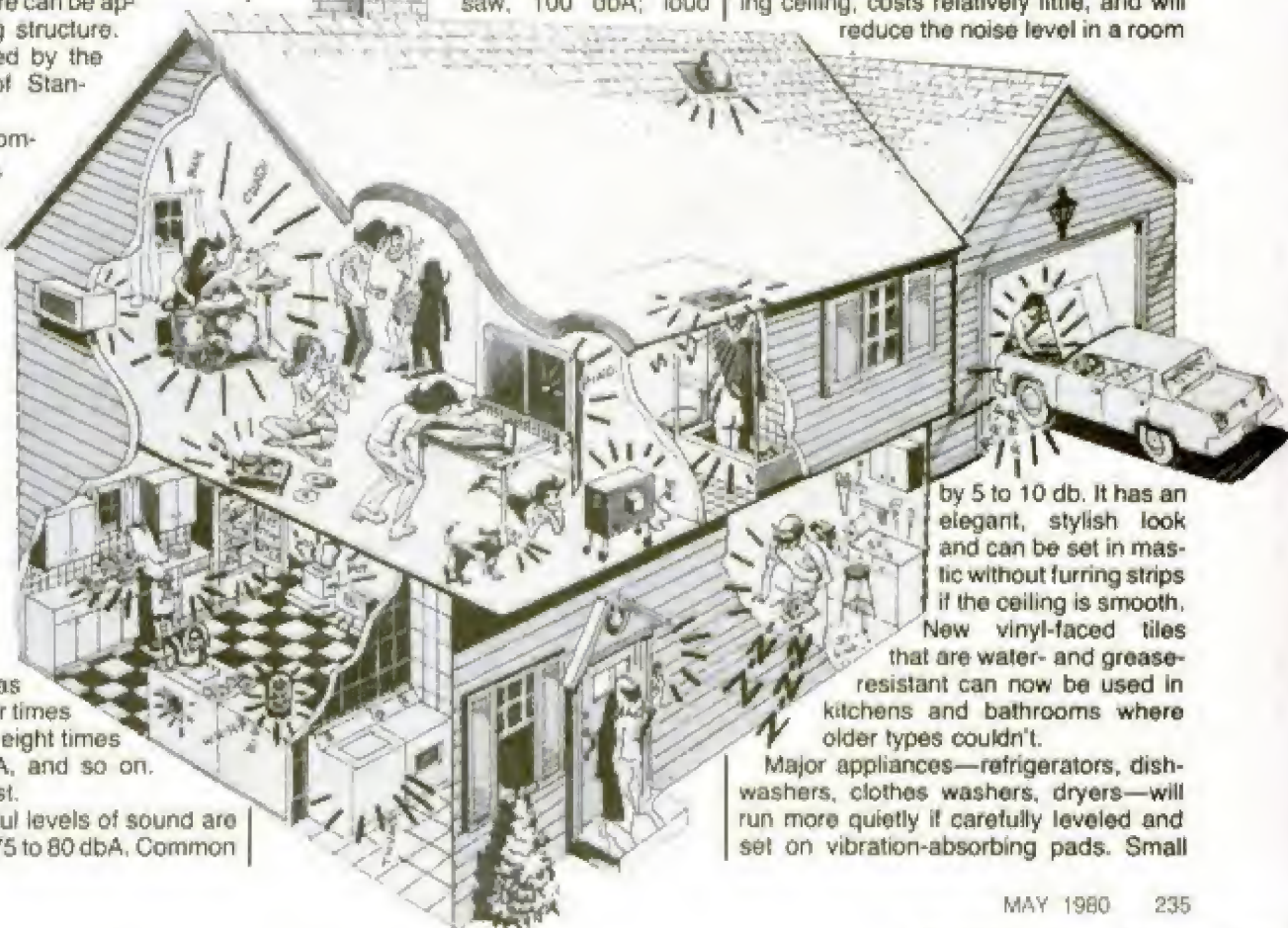
### Sound vibrates

Sound waves travel in a series of vibrations. The object is to stop these vibrations by isolating them, absorbing them or changing their direction. In general, a soft surface will absorb sound and a hard surface will reflect it, but neither will do both. Porous, textured materials like curtains, carpeting and acoustical tile are excellent for muffling noise within a room, but do little to stop it from passing through to an adjoining room. Smooth, rigid materials like plaster and plasterboard help to block sound from passing through, but bounce it right back into the room where it originated.

Here's where you have to choose the approach that best suits the problem. If you want to quiet noise *within* a room, concentrate on absorbent materials. Acoustical tile is easily put up over an existing ceiling, costs relatively little, and will reduce the noise level in a room

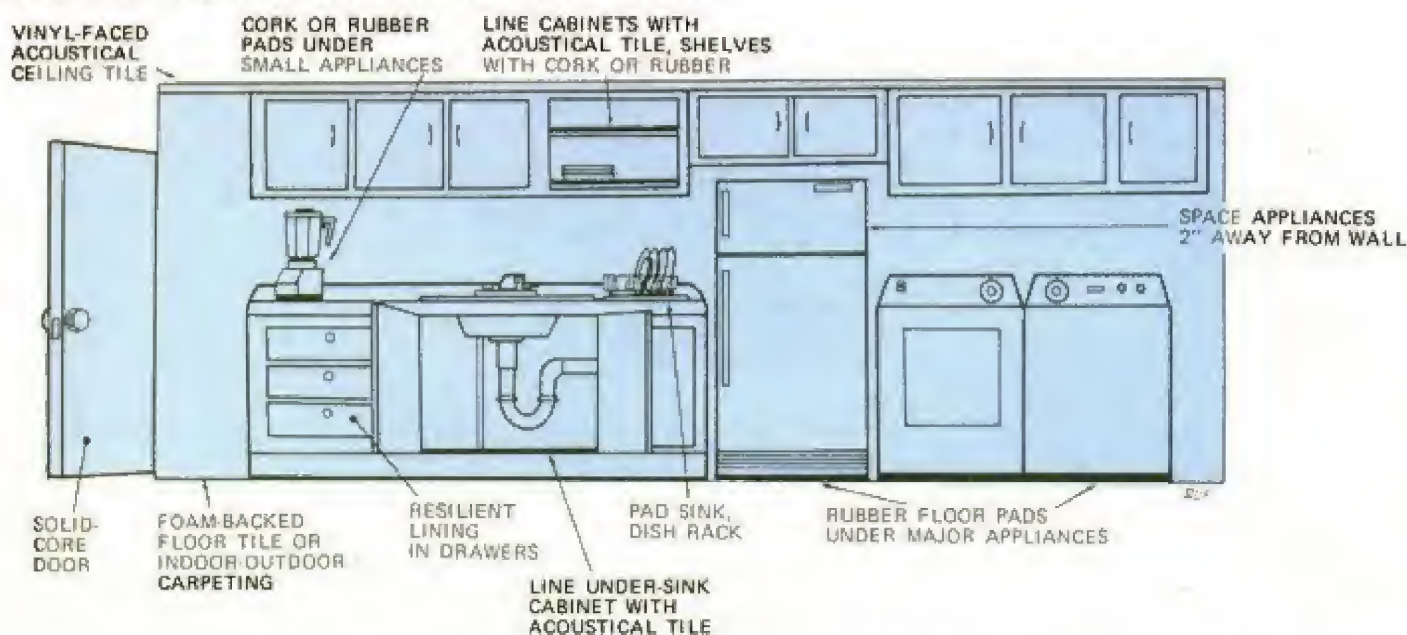
by 5 to 10 db. It has an elegant, stylish look and can be set in mastic without furring strips if the ceiling is smooth. New vinyl-faced tiles that are water- and grease-resistant can now be used in kitchens and bathrooms where older types couldn't.

Major appliances—refrigerators, dishwashers, clothes washers, dryers—will run more quietly if carefully leveled and set on vibration-absorbing pads. Small





## THE NOISIEST ROOM IN THE HOUSE: QUIETING KITCHEN CLATTER



The kitchen is usually the noisiest room in the house. Using solid-core doors will help keep sound from being transmitted to other rooms. Make sure major appliances sit level, are spaced at least 2 in. away from wall, and rest on rubber floor pads. Place small appliances on cork or rubber mats. New vinyl-faced acoustical tile is water- and grease-resistant, can be used on ceiling and as a wall liner in cabinets. Line shelves and drawers with cork or rubber. Cover hard floor surfaces with resilient foam-backed tile or washable indoor-outdoor carpeting.

appliances can be placed on cork or rubber mats. Kitchen and bathroom cabinets can be lined with cork or acoustical tile.

Heavy drapes hung in folds and thick carpeting with underlayment will also cut room noise by 5 to 10 db. And remember, you don't have to have a window as an excuse for putting up a curtain—many attractive, modern room treatments feature fully curtained walls where there are no windows at all. Almost anything you put on walls, in fact, will help to absorb or disperse sound waves—books, knickknack shelves, decorative wall hangings.

Placing hi-fi speakers on resilient pads will reduce sound transmitted to other rooms without affecting the quality of reproduction within the listening room. A

noisy airconditioner can be quieted with a rubber gasket between the cabinet and window frame. Squeaky floors and stairs can be silenced as shown (see drawings, page 238).

The thumps and grunts caused by "water hammer" in plumbing pipes are not only disturbing, but can lead to costly damage. New commercial expansion chambers solve this problem and are easily installed in existing plumbing, even in the rubber-hose lines that feed a clothes washer. They consist of a plastic ball containing an air reservoir and flexible diaphragm. When water is abruptly shut off, the diaphragm and air cushion absorb the shock of the sudden backflow, ending the harmful hammering effect (see page 238). Because the air cushion is isolated by the diaphragm, it can't be absorbed in the water, as happens in conventional air chambers. The new Mini-Trol units can be installed in any position and do not need periodic draining to restore the air.

### Soundproofing a wall

Adding a sound barrier to an existing wall is easier than it may seem. Applying a new facing of inexpensive plasterboard will help to block sound from passing through the wall and is a good way to quiet a bedroom, study or living room that

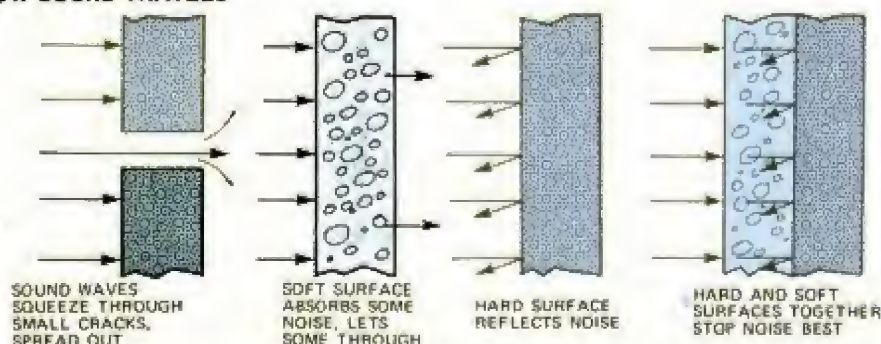
backs up to a kitchen, bath or playroom. In this case, the new surface is installed on the "noisy" side of the wall—the side facing the source of the sound—to reflect noise back where it came from.

The trick here is to set the plasterboard in thick beads of panel adhesive, using as few nails as possible. The resilient adhesive provides a cushion to absorb vibration, and the tiny air gaps between the new and old wall facings act as sound traps. Another trick: Leave ¼-in. spaces at the top and bottom of the plasterboard and fill these with caulking. The spaces isolate the plasterboard, to prevent noise transmission through the floor and ceiling, and are concealed by moldings.

For added soundproofing, apply plasterboard to both sides of the wall. Also, covering it with wood or hardboard paneling offers a triple bonus: It gives an attractive appearance, beefs up the sound barrier and eliminates taping of seams and nailheads (though cracks should be rough-caulked to prevent noise leaks).

If you're putting up a new partition in a basement, attic or room addition, try the staggered-stud method shown here (page 237). By alternating 2×3 studs at opposite edges of 2×4 plates, you create a gap between the two rows of uprights—neither side of the wall touches the other, providing good acoustical isolation. For

### HOW SOUND TRAVELS

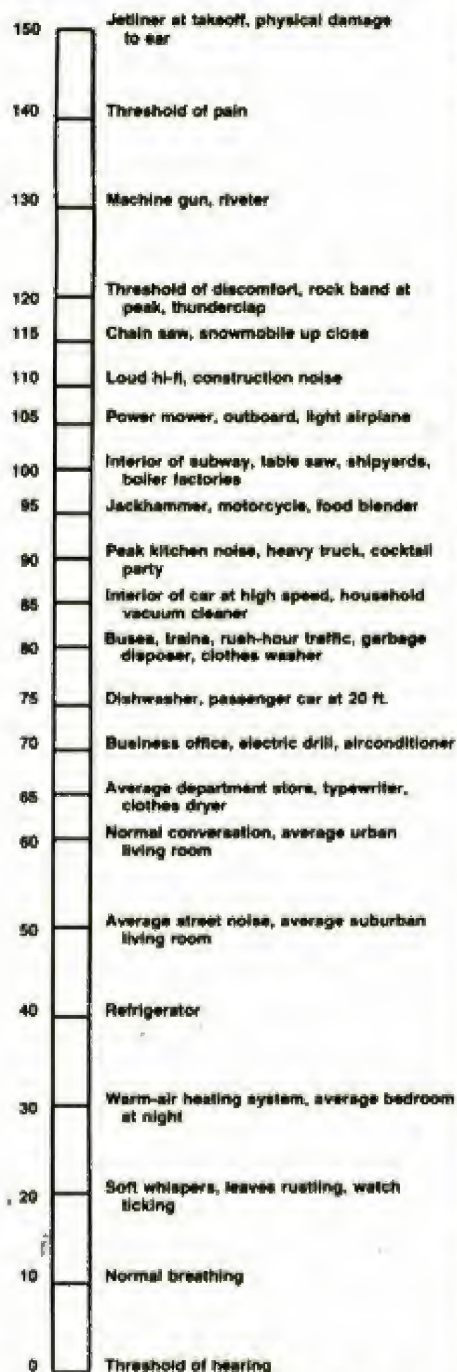


Drawings at left show effect of different materials on the transmission of sound. Holes and cracks let more noise through than their size would indicate due to sound waves' ability to squeeze through openings and spread out on other side. Soft surfaces like acoustical tile absorb noise in the room where they're used, but let some sound pass through to other rooms. Hard surfaces like plasterboard block sound, but reflect it back where it originated. Combining both hard and soft materials is best. You can quiet noise in a room; keep it out of others.



## HOW TYPICAL NOISES COMPARE IN INTENSITY

SOUND LEVEL IN DECIBELS (dba scale)



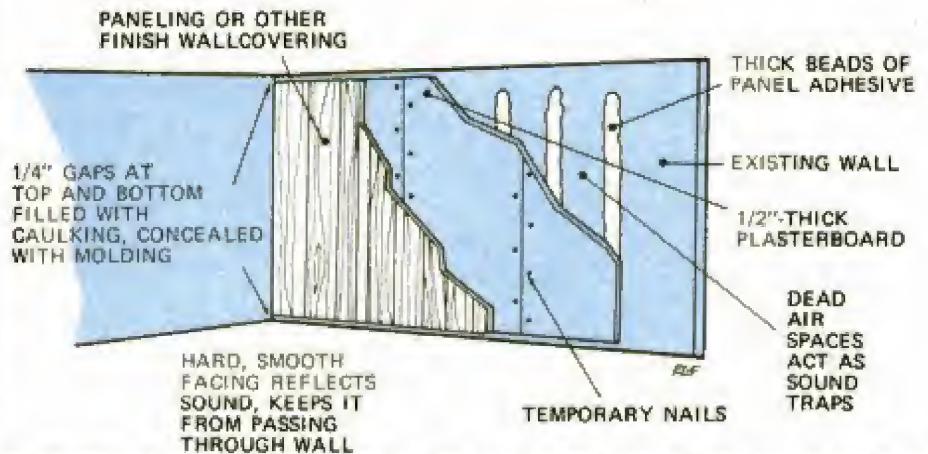
Note: The sound levels given above were compiled from a number of sources and necessarily represent some arbitrary compromises. Actual levels may vary considerably under different conditions.

added sound absorption, you can weave 1-in.-thick, blanket-type thermal insulation between the offset studs.

### Soundproofing a ceiling

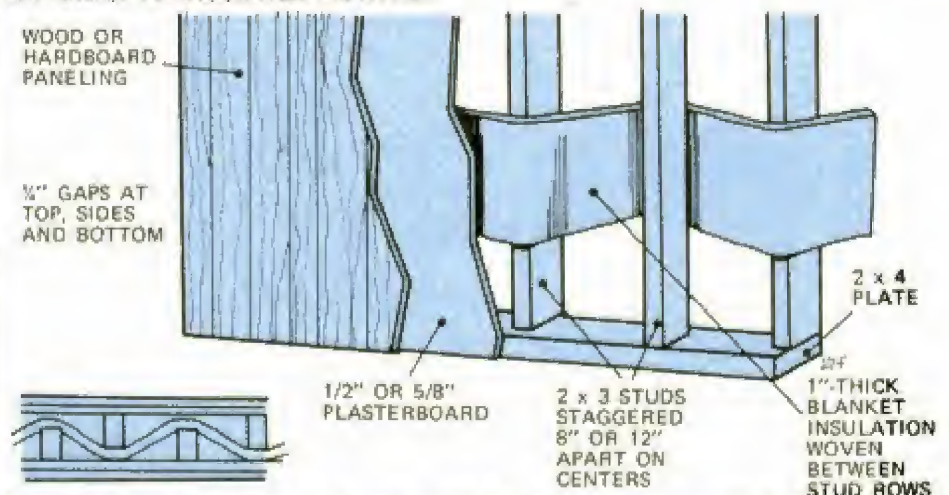
One of the noisiest situations is where a basement shop or playroom falls directly under a bedroom or other upstairs area where you want maximum quiet. The solution here is a barrier ceiling on the underside of the floor. If the joists are exposed, staple 3-in. insulation between them and nail up plasterboard. Then cov-

## SOUNDPROOFING AN EXISTING WALL



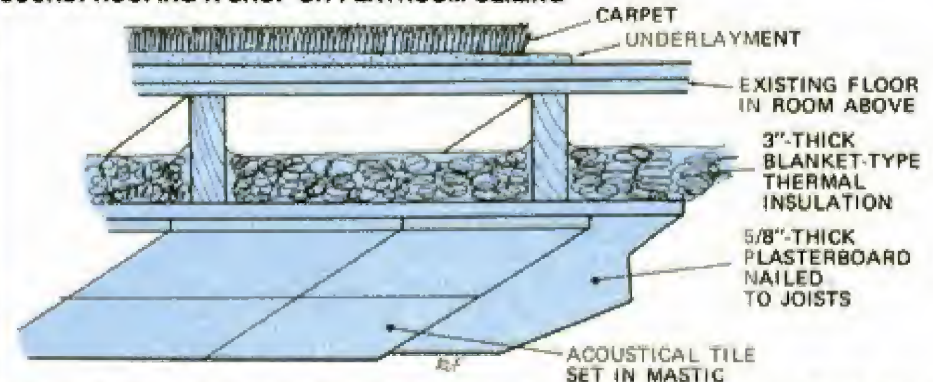
Adding new wall facing of plasterboard on inside of a noisy room will help stop sound from carrying to adjacent bedroom or other area where you want quiet. Set sheets in thick beads of panel adhesive, using only enough nails to hold them temporarily in place. Adhesive acts as cushion to absorb vibration. Leave 1/4-in. gaps at top and bottom to isolate plasterboard and keep it from transmitting sound through ceiling and floor.

### PUTTING UP AN INSULATED PARTITION



Staggered-stud wall makes ideal partition in a basement playroom or other high-noise area. Offsetting 2x3 studs on 2x4 plates isolates opposite wall faces so they don't touch and can't transmit sound. Weaving 1-in.-thick, blanket-type insulation between stud rows further reduces sound. Cover each side of wall with layer of plasterboard followed by paneling. Leave 1/4-in. gaps all around, caulk, conceal with molding.

### SOUNDPROOFING A SHOP OR PLAYROOM CEILING



You can quiet noise coming from a basement shop or playroom this way: Staple 3-in.-thick, blanket-type insulation between ceiling joists. Then nail plasterboard to joists and cover with acoustical tile set in mastic. The plasterboard and insulation reduce sound transmitted upstairs; the tile helps to muffle noise in the basement itself.

or the plasterboard with acoustical tile set in mastic. Where the joists are enclosed, nail up furring strips and staple 1-in. insulation between them. Then put the plas-

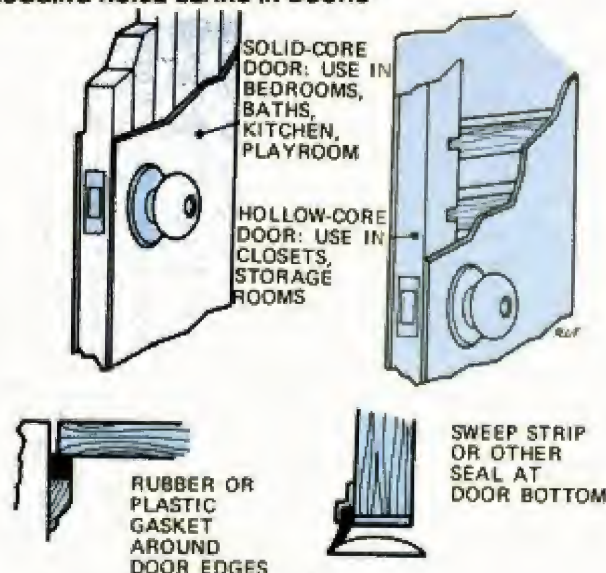
terboard and the acoustical tile in place.

The combination of insulation, plasterboard and tile provides the best of both worlds: The hard plasterboard reflects



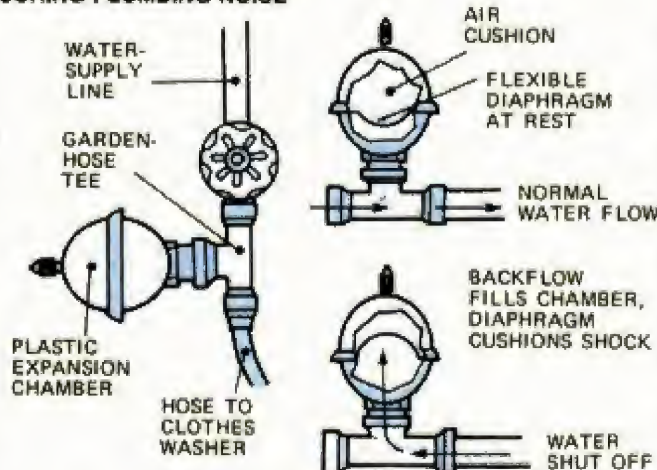
Thinly paneled hollow-core doors vibrate, let noise pass through from one room to another. Solid-core doors, though more expensive, can block sound, are better in critical areas like the bedrooms, baths, kitchen, playroom. Seal cracks around doors with rubber or plastic weatherstripping. Installed between door face and stop strips. If necessary, move stops back slightly to provide clearance for gasket. Seal door bottoms with sweep strips that sit snug against sill.

## PLUGGING NOISE LEAKS IN DOORS



Easy-to-install expansion chambers can quiet noisy "water hammer" in plumbing. Plastic ball contains flexible diaphragm that absorbs sudden shocks when water flow is shut off. It can be installed in clothes-washer lines with simple garden-hose tee (right) or in rigid plumbing with other fittings. Mini-Trol units cost about \$10 each, are made by Amtrol Inc., 1400 Division Rd., West Warwick, R.I. 02893.

## CURING PLUMBING NOISE



sound, and the soft insulation and tile absorb it. Together, they block the transmission of sound upward through the floor and also soak up noise below it.

## Sealing noise leaks

Sound waves flow almost like water, seeping through the tiniest holes and cracks. When they encounter an opening, they squeeze together, slip through, then spread out on the other side. Because of this strange phenomenon, a slightly open door or window will let almost as much sound through as a fully opened one.

The moral here is not only to keep doors and windows closed as much as possible, but also to seal them tightly. Loose-fitting windows and doors should be weatherstripped—even interior doors (see drawing above). Hollow-core doors save money, but do little to stop the transmission of sound. Switching to the solid-core type in critical areas, such as bedrooms, bathrooms, kitchens and playrooms, can be worth it.

Stairwells amount to huge tunnels between floors, readily channeling noise through a house. Install doors at the head and foot where feasible, carpet the steps and consider adding acoustical tile overhead—all will help.

PM

## HOW NOISE CAN HURT YOU

A homeowner felling trees with a chain saw looked up to see his wife approaching and shut off the tool to greet her. To his astonishment, her lips were moving, but nothing was coming out. A father picking up his teen-age daughter after a rock concert was shocked to find she couldn't hear what he was saying.

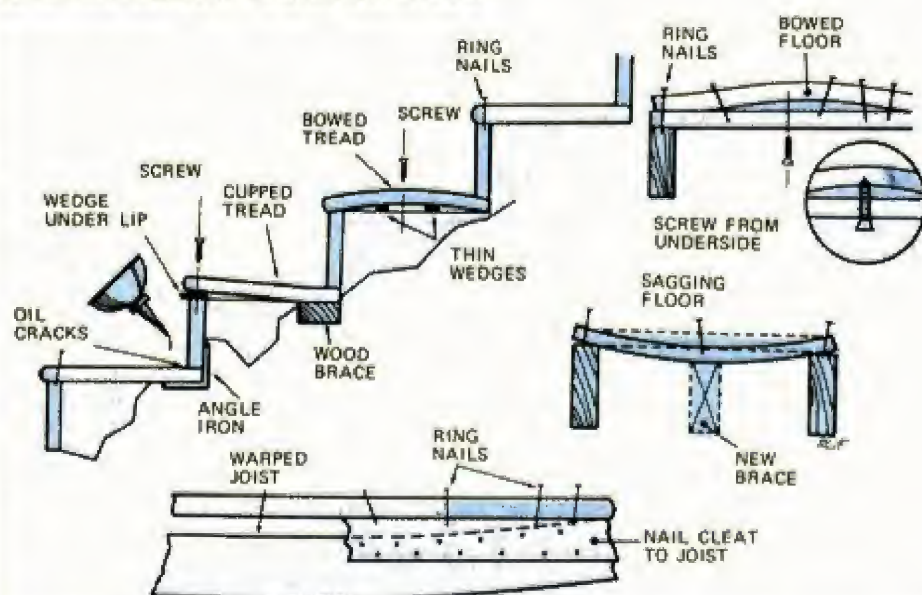
Such instances of temporary deafness are not uncommon. They're caused by prolonged exposure to high levels of sound and may last a few minutes to several hours. While not in themselves a sign of permanent injury, they indicate the degree to which the human ear is sensitive to high levels of noise.

The problem is that your ears, unlike some other body organs, do not repair themselves when damaged. Sound waves are transmitted to the brain by thousands of tiny, delicate hair cells in the inner ear. Loud sounds literally blast these fragile cells to destruction—the way a speaker cone can rupture if you turn the hi-fi volume up too high. Only a few cells may be destroyed at a time, but once they're gone, no new ones grow in their place. Gradually, more and more of these sensitive cells disappear until your hearing ability is seriously impaired.

Such deterioration is progressive, cumulative, irreversible and—ultimately—total. Under normal conditions, it takes years and may not show up until well into old age. But constant exposure to excessive noise accelerates the process and can lead to premature deafness.

Nor is ear damage the only danger you face. Excessive noise has been linked to a variety of other ailments, including heart disorders, high blood pressure, increased cholesterol buildup, stomach ulcers, gastrointestinal dysfunction, diabetes and emotional upsets. It is not unusual for NASA space technicians to experience dizziness, nausea and fainting spells after a rocket launch. In the home, the constant aggravation of noisy surroundings can cause fatigue, tenseness and irritability. It can disrupt family harmony, interfere with restful sleep patterns, decrease working efficiency and generally make it difficult to relax and enjoy life—a lot of reasons for doing something about it.

## SILENCING SQUEAKY FLOORS AND STAIRS



To quiet creaking stairs, apply mineral oil or silicone spray to joints and drive in ring nails at angle. Treads too cupped or bowed to lie flat can be shimmed against moving with small wedges. Add wood or angle-iron cross braces under risers from below. Bowed floors can be pulled down tight with ring nails from above and screws up through subfloor from below. If underside is not accessible, screw down from top. If floor sags, block it up with new braces under low spots. Where a warped joist no longer supports the floor, nail cleat along side to bear against floor and keep it from flexing. Use underlayment under all carpets to absorb noise, and cover stairways with runners.



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FTC Report MAY '78.



## 'IT'S GREAT TO LIVE UNDERGROUND!'

(Continued from page 177)

portion of Brown's statement. Not one underground house in our report was invaded by the world's oldest and most common pests: the ant and the roach.

So much for apprehensions of above-ground dwellers. Aside from pleasures named by underground people, what motivated them to make the move?

"I've been a contractor for 20 years and lived in a lot of houses,"

says Gary Davis of Granite City, Ill. "I started researching underground houses because I wanted to build a house that wouldn't burn down or blow down, delivered more security, could be built faster and cheaper, was immune to tornadoes and lightning storms, had low maintenance and wiped out those exorbitant fuel bills.

"I built the first one on an experimental basis in 1976 for myself, my

wife and our six children. The house has delivered everything we were seeking, and more."

### Fuel bills drop sharply

Energy saving is a recurrent theme among owners of underground homes. Davis says he kept strict records of heating costs during February 1979, when the average temperature outside was 17°F. "Inside, we maintained an even 70° to 72°F. We paid \$16.40 to burn 16 100-watt bulbs and intermittently use two electric space heaters to warm 4422 square feet. Heating the same space in our former above-ground house would have cost \$247."

Tales of dramatically slashed heating and cooling bills were common enough, although no one reached the elusive "zero-energy" state. Several heat with wood stoves. Rod Ford (in Ohio) manages with one wood stove and one 750-watt space heater. Dona and Gayle Scafe (in Missouri) burn 1 to 1½ cords of wood a winter. Lee Bull (in Ohio) spends less than \$200 a year to heat his house with a gas furnace.

Gary Davis (in Illinois) operates a central air conditioner during the summer about twice a week for half-hour periods. "That's mostly for dehumidification," he says. "The air gets wet because we have a swimming pool in the middle of our house."

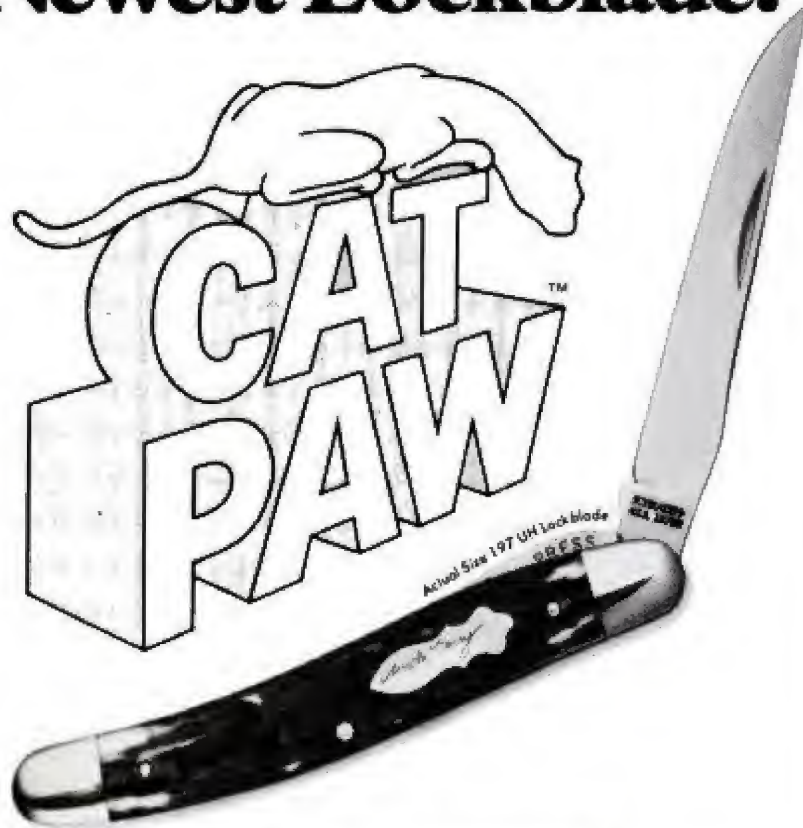
Dr. Lester L. Boyer, professor of architecture at Oklahoma State University in Stillwater, Okla., surveyed owners of 70 underground homes in the state. (Dr. Boyer says there are more than 200 in Oklahoma, nearly all built within the last five years.) "Why did you decide to build underground?" Dr. Boyer asked the owners. The eight most-repeated answers, in order, were: reduced heating, reduced cooling, storm protection, alternate energy option, less maintenance, security from vandalism, reduced insurance and personal privacy.

### Applause for the quiet

Tenth on Dr. Boyer's list was "reduced environmental noise." But after families have lived in underground houses, they can't stop talking about the quiet.

"We barely heard the hurricane that skirted the area two years ago," say Will and Jeanne Morris, who rented William Morgan's earth-sheltered house in Jacksonville, Fla. Another tenant, Dr. Harold Bridges,

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## 'IT'S GREAT TO LIVE UNDERGROUND'

(Continued from page 240)

says, "When I'm up in the loft, the sound of the radio playing downstairs in the kitchen seems to be right next to my ear—in fact, all around me. The acoustics in here are fantastic."

"We're spoiled," says Rod Ford. "When my wife, Jean, and I visit our relatives, we can't sleep for the noise of traffic and wind, and especially rain. We can literally hear a pin drop in our house, no matter what's happening outside."

"I couldn't get used to the quiet at first," says Gary Davis. "For weeks, I'd wake up with a start at 4:00 a.m. because ice was falling into the automatic ice-maker tray."

Good terms on fire and theft insurance were mentioned by many. "We got the best break available," says George Hagman. According to Don Metz, Bill Alcorn had two insurance companies bidding for his business, and he wound up with a 25 percent discount. Some further pluses mentioned by owners include:

- No chance of water pipes freezing in the winter when the house is left empty.
- Never a need to re-roof. And not much re-siding to do when the time arrives.
- A strong sense of security.
- A cozy feeling. Rod Ford designed his house with bedrooms against the rear wall. "We get some daylight in the bedrooms until about mid-afternoon and need lamps after that. But it's a nice, secure, private feeling back there."
- Fewer windows to wash.
- Very little dust. Gary Davis says his wife, "PJ," has to dust once a year to keep in practice.

### There are some problems

Life underground can't be all moonlight and roses, and it isn't. George Hagman worries about neighborhood children playing on his sodded roof and falling over the forward edge. Rod Ford says his biggest worry about the roof is that deer will fall from it. He's raised a two-foot parapet at the roof edge to signal the drop. Dona and Gayle Scafe solved the problem with a hedge along the roof edge.

Living underground is still a new concept and draws the curious: The Texans I interviewed wanted anonymity "because when we used to eat on the terrace above ground, it might as well have been feeding time at the zoo. People came from miles around to stare at us and our house." Dr. Bridges says of the Jacksonville house, which faces the

beach, "I'll be reading or watching TV in the evening, and glance out the window [which has 'one-way' glass]. There are a dozen or so people standing in the sand, trying to peer into the house. It rather makes me feel like an animal in a cage."

George and Ruth Hagman solved that problem by inviting people to tour their house for a modest fee, which they then turn over to a local charity.

Sandra Bull recalls one occasion when her youngest child fell from his bike and pinched his fingers, an accident she was unaware of until the boy rang the front doorbell. From inside, she couldn't hear him crying.

Finally, Lee Bull said his sister stayed in the house for a month while they were away, and "it drove her crazy. She said it was too confining. But, then, she lives in Tucson with a view for miles to the moun-

### Where to get information on underground living

You could begin by writing the American Underground-Space Assn. (AUA), c/o T.L.H. Associates, Suite 900, Minnesota Building, Fourth and Cedar, St. Paul, Minn. 55101. AUA will send you free background data on underground construction, plus an order form to obtain more detailed publications.

Or send a stamped, self-addressed, business-size envelope to Architectural Extension, 115 Architectural Building, Oklahoma State University, Stillwater, Okla. 74074. You will receive a free booklet on earth-sheltered structures and order blanks for additional data. There is even an order form for a T-shirt with an imprint, "I dig earth-sheltered housing."

Three commercial firms to contact are: Terra-Dome Homes, 14 Oak Hill Cluster, Independence, Mo. 64057. The company will send you a free brochure describing the system of construction it has invented. Or you can order *Twenty-first Century Homes* by Gayle Scafe of Terra-Dome, for \$5.75, which includes the cost of mailing.

U-Bahn Earth Homes, 4008 Braden, Granite City, Ill. 62040. You will receive a free four-page brochure describing underground houses constructed by the firm, plus an order form to send for an illustrated plan book. Or you can order the plan book directly for \$5.

For \$3, you can buy a copy of *Primer to Earth-Sheltered Living*, a 24-page booklet published by Underground Homes, 700 Masonic Building, Portsmouth, Ohio 45662. The firm also offers a 44-page plan book for \$6.95. Free descriptions of both manuals will be sent on request.

tains. I guess it depends on what you have to see."

The people I interviewed may well be more adventurous and flexible than most. Many of them had a warm sense of humor. The Texans envision a subdivision of earth-sheltered homes on property they own. "We're toying with calling it 'Prairie Dog Village.'"

Lloyd Remington, a professor of chemistry at the University of North Carolina at Asheville, named his house (designed by Richard F. Webster) "Hobbitat." And one designer, who prefers to remain nameless, calls himself an "Earthitect."

One thing is certain. The underground movement has dug in, and it's here to stay.

FM



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thru-hub exhaust from 20-hp up. Like power trim and tilt, standard on the 85 and optional on the 50 and 65.

There's a rugged shock absorbing prop system to minimize drive pin hassles. And CD ignition on engine sizes where it's needed. What you won't find are any unnecessary frills or gimmicks.

Finally, Spirit insisted on tank-testing and running each engine before it leaves the factory because you shouldn't have to test drive an engine after you buy. This helps make Spirit's full year limited warranty good for me. And good for you.

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*Curt Gowdy*



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## HYDROGEN FOR CARGO PLANES

(Continued from page 121)

holds promise, although it may not be a panacea for future energy problems. A panel from the National Research Council, working arm of the nonprofit National Academy of Sciences, reported last year that hydrogen has a lot going for it. It's abundant. It can be drawn easily from water or hydrocarbon sources such as coal or natural gas. And it can feed into internal-combustion engines. Cars of the future might be powered by liquid hydrogen, the panel said, or by hydrogen released from hydrides—the chemical combinations of hydrogen with other elements.

### LH<sub>2</sub> means longer flights

But the panel expressed some reservations in the report, commissioned by the U.S. Department of Energy. Electric cars powered by hydrogen-air fuel cells would be more fuel-efficient than cars burning hydrogen, the report argued. Overall, hydrogen is currently more expensive than either natural or synthetic hydrocarbons used as fuels. And a large market for hydrogen is unlikely to develop unless there are future limitations on the availability or use of hydrocarbons. On the other hand, the panel concluded, as a fuel for aircraft, liquid hydrogen would permit longer non-stop flights than are possible currently.

"If a national goal for the development of a long-range supersonic transport were to be adopted, serious consideration should be given to the use of hydrogen as a fuel," the panel recommended.

Further support for hydrogen power comes from studies commissioned by NASA to see if major air terminals could stock and transport fuel without endangering passengers. In one research project, Boeing developed a scenario around Chicago's bustling O'Hare International Airport. Boeing researchers suggested that fuel should be stored in above-ground tanks, feeding fuel tanks in the fuselage instead of the wings. For safety, boil-off or vented gases should be recovered, Boeing recommended. But overall there are no overwhelming engineering problems. O'Hare, in other words, could handle hydrogen by the 1990s.

### But is it safe?

Fears have always been raised by new forms of energy until men learned how to use them. The first automobiles were preceded by a man on foot carrying a red flag. The

(Please turn to page 246)

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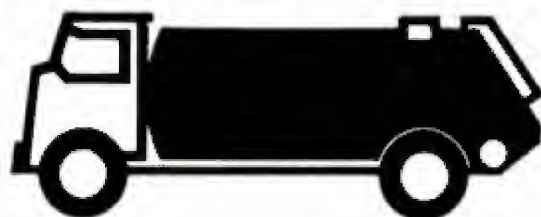
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## HYDROGEN FOR CARGO PLANES

(Continued from page 244)

first tank trucks of liquid hydrogen permitted to move on U.S. highways were escorted front and rear by red Jeeps.

Even though hydrogen is used daily in industry, suggestions for its use in something as common as cargo transport scare many people. They are still caught up in the "Hindenburg Syndrome," the remembrance of the dirigible that caught fire during a landing at Lakehurst, N.J., in 1937. Thirty-five of the 97 persons aboard died. Few recall that the hydrogen-filled *Graf Zeppelin* made regular, safe crossings of the Atlantic from 1928 until its retirement in 1937.

Nonetheless, the questions and fears are there: Should hydrogen be stored at airports? Is it safe to handle? If cargo planes work, the next step would be passenger flights. Will the passengers be safe?

The facts are these:

■ Tanks in an L<sub>H2</sub> vehicle are filled only with pressurized hydrogen which can't burn or detonate. Gasoline tanks in cars and kerosene tanks in aircraft contain fuel vapor and air, and, depending on the conditions, a slight spark can set off the fireworks.

■ Hydrogen becomes a fire hazard only if it leaks from the tank, but because it is 14 times lighter than air, it dissipates upward at a rapid rate. The flame of a hydrogen fire does not spread like burning gasoline or kerosene.

■ Although gaseous hydrogen ignites more readily than other fuels, it produces no noxious fumes and emits little infrared heat laterally from the sides of the flame. Objects not directly in the flame will not burn.

With adequate ventilation, leak prevention and elimination of stray ignition sources, hydrogen should be welcomed by airport fire chiefs.

Even though the shift to hydrogen-fueled aircraft appears logically compelling and the technology is generally well known, the change-over will be complicated, primarily because of all the pieces that need to fall into the puzzle. Who will build the hydrogen production, liquefaction and storage plants? Who will design the plant-to-plane refueling system, and who will hire and train the personnel needed to operate the experimental airline proposed by Brewer?

Brewer isn't alone in thinking it's time to face these and other questions and then give hydrogen a chance—once again—to fly. **PM**



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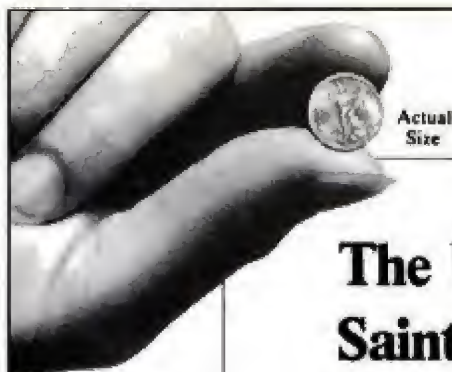
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All orders subject to acceptance.

Allow 4-6 weeks for delivery.



## CRADLES WITH OLD-TIME CHARM

(Continued from page 129)

cent with denatured alcohol. Let the shellac dry at least four hours. Then rub lightly with 180-grit paper, dust and tack off. Brush on a coat of varnish thinned slightly with turpentine. Allow this to dry overnight, at least, then sand the cradle lightly with a 200-grit paper wrapped around a soft sanding block, dust and tack off.

Finish by applying varnish as it comes from the can. Let the cradle

## MATERIALS LIST—COLONIAL CRADLE

Key	No.	Size and description (use)
A	2	$\frac{1}{2} \times 2 \times 28\frac{1}{2}$ " plywood (end)
B	2	$\frac{1}{2} \times 22 \times 27$ " plywood (end)
C	2	$\frac{1}{2} \times 4 \times 34\frac{1}{2}$ " plywood (rail)
D	2	$\frac{1}{2} \times 17\frac{1}{4} \times 20$ " plywood (head/foot)
E	1	$\frac{1}{2} \times 13\frac{1}{4} \times 30$ " plywood (bottom)
F	2	1"-dia. $\times$ 33 $\frac{1}{2}$ " dowel (guard)
G	26	$\frac{1}{8}$ "-dia. $\times$ length to suit, dowel (baluster)
H	2	decorative pull rings
I	4	$\frac{1}{4} \times 1$ " dowel (pin)
J	2	$\frac{1}{4} \times 3$ " locking pin, turn from round stock

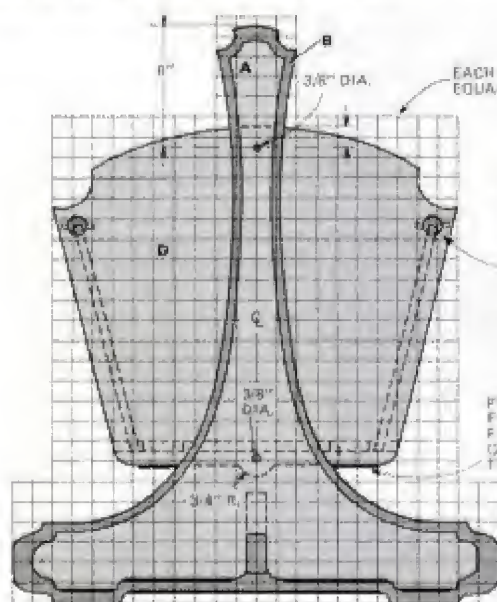
Misc.:  $\frac{1}{2}$ " scrap plywood for 2 spacers, 2  $\frac{1}{2} \times 2\frac{1}{2}$ " carriage bolts, 2  $\frac{1}{2}$ " cap nuts, glue, 4d finishing nails.

cure for a week before use. Though a cradle is used when the baby is at an inactive age, take the precaution to

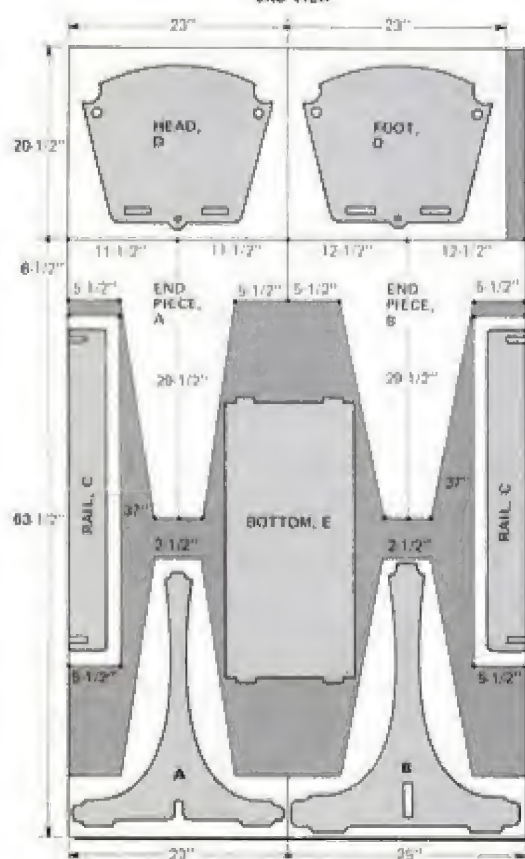
(Please turn to page 250)



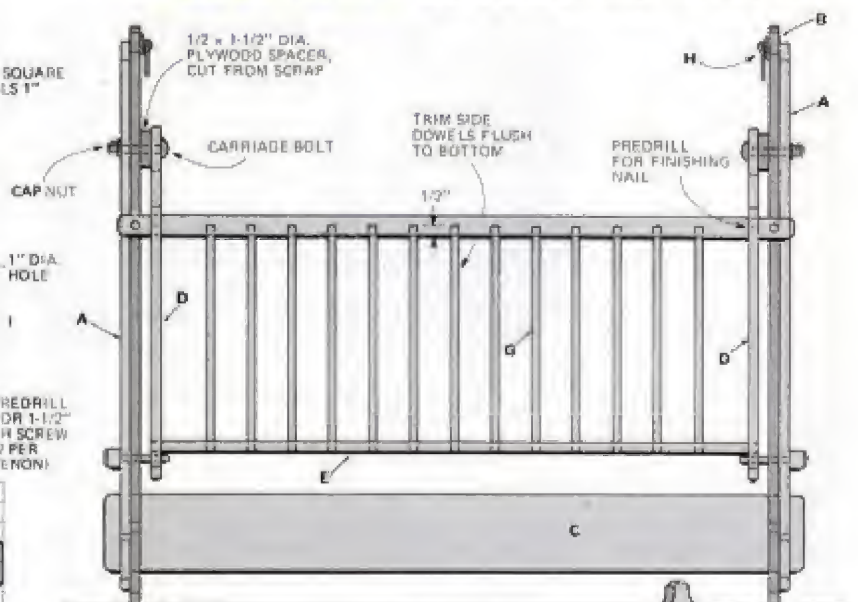
Dowel lock pin holds cradle rigid when desired. Clamp the cradle to the support to assure accuracy when you bore holes.



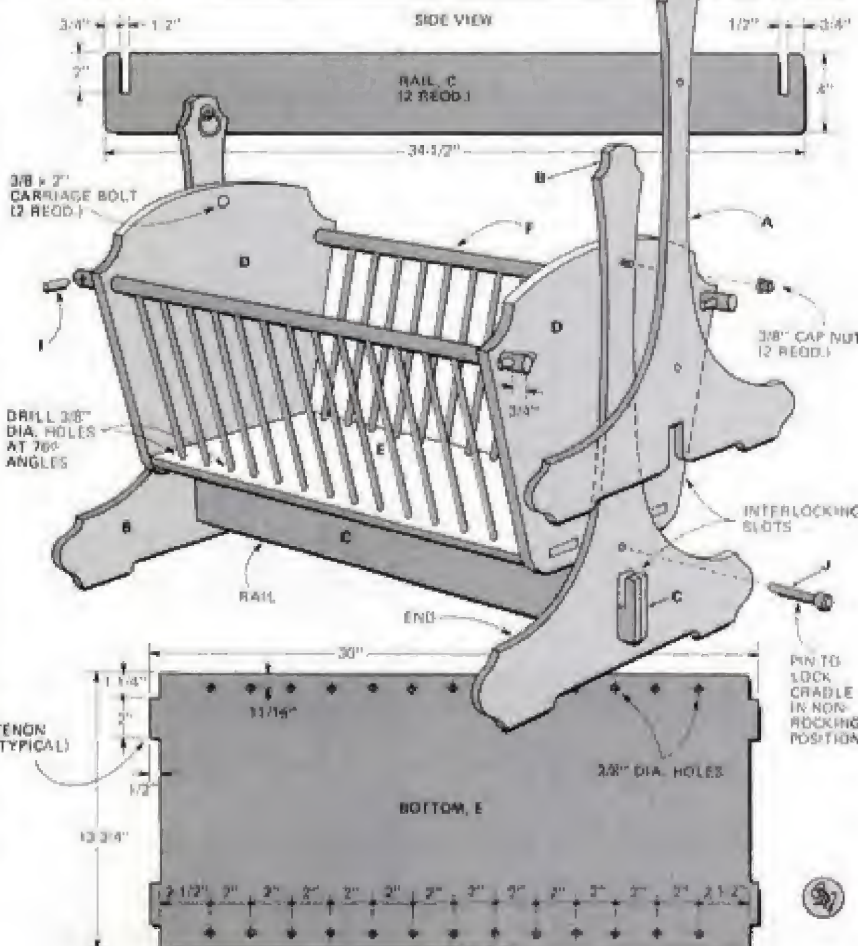
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Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.



# Tough enough to take on the Baja.



## And come back for more.

Gott® super-insulated coolers and ice chests. Tough enough to keep cool in the scorching heat of the Baja. And tough enough to shrug off the impact of this 2-ton Baja race machine.\* From our patented refreeze series ice chests and compact Tote 12's, to the new Tip 'N' Tap beverage coolers, make it Gott. The one for rugged durability and holdin' the cold.

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\*Not a single cooler or ice chest was damaged by the 45 mph impact. One reason Gott was used exclusively in the Baja by the Scout Racing Team.

## CRADLES WITH OLD-TIME CHARM

*(Continued from page 248)*

use only nontoxic finishing materials. Check labels when buying.

### The hanging cradle

Following the cutting pattern, lay out cradle parts on the half sheet of plywood. Temporarily tack cleats to the end and side panels and make a test assembly without glue. Modify dimensions if necessary, take apart and reassemble with glue and nails. Finish cradle as described above.

To hang the cradle, screw two enameled eye hooks (rated at 50 lbs.) into a ceiling joist. Thread ordinary marine line or a strong decorative cord through the holes in the cradle and the hooks. After knotting the line, unravel ends to make tassels.

### The early-American cradle

This cradle, which takes longer to build, can be stained, painted or antiqued. It requires slightly less than a full sheet of 1/2-in. plywood. If you have a 14x30-in. scrap of plywood handy you'll only have to buy a 4x4-ft. sheet. You'll also need dowels.

Cut the parts and assemble as shown in the drawing. Notice that both ends have two panels, making it a lot easier to assemble with rigidity; notched outside panels simply slip into the rail and lock it in place.

To assure accurate holes for the side rails, clamp both top dowels (F) in place on the cradle bottom and mark the dowel locations on both members at the same time. Make match marks on the dowels and cradle bottoms, so each dowel can be mated to its matching hole when you are assembling permanently.

Cut a plywood jig to guide your portable drill for boring the angled 3/8-in. holes in the cradle bottom. Use the same bit in your drill press to bore the holes in the dowels (F). Use the press depth stop to be sure you don't bore through the dowels. For accuracy, clamp the dowels in a V-block.

Assemble the cradle using glue and nails and set the assembly aside. You can also assemble the ends and rail with glue and nails.

The next day, position the cradle in its support and hold it in place with several handscrew clamps. Bore the pair of holes for the carriage bolt. Insert the bolts and secure with the cap nuts. Place the cradle on a level surface; the vertical end brackets should be at the center of the cradle. Insert some scrap material between the cradle end and support and clamp the unit rigidly. Bore the holes at one end (or both if desired) for the lock pin. Finish as described above. **PM**

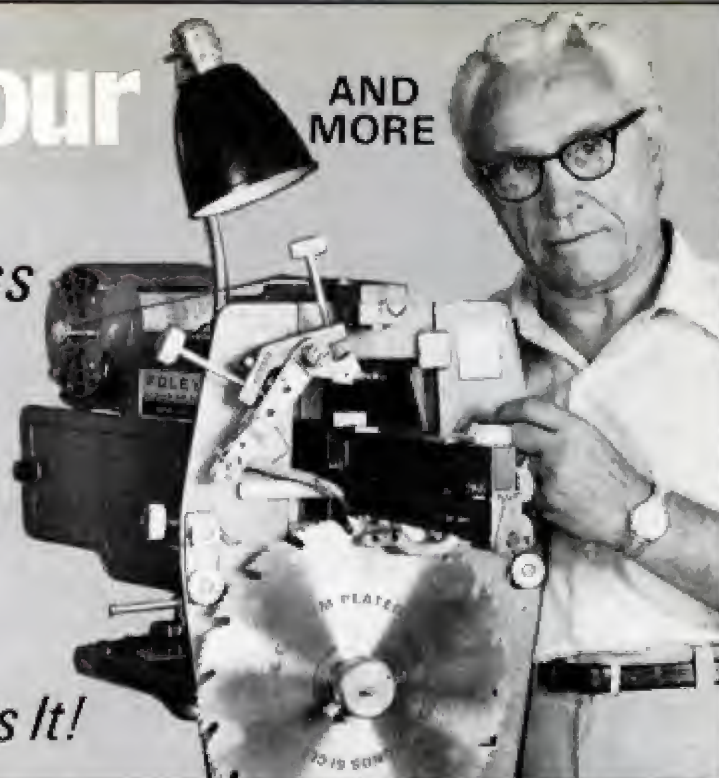


# Earn \$8 an Hour

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Weekends in a Business  
of your own!*

## Sharpening Saws & Tools

*For Industry and Homes!  
Every Neighborhood Needs It!*



AND  
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### Sharpening is Big Business ... and Profitable Too!

Work part time, full time, right at home. No layoffs. No strikes.

**This can be one of the most important decisions you ever make**  
Going into business for yourself can be the most exciting and rewarding decision you're likely to make in your lifetime.

Owning your own business brings you a sense of independence. You're the boss, setting your own work hours. Your own effort builds the business for yourself and your family. You can achieve great satisfaction and profits, if you choose and manage your business wisely. That's why so many men, just like you, are cashing in on the big profits to be made in this fast-growing service field.

The sharpening business allows you to get started with only a minimum investment, requiring little space and effort for a successful operation. It lets you build and expand as fast, or as slowly as you like. You pocket most of the money you take in, because there are exceptionally high profits with no investment in merchandise.

If you need only \$200 or \$400 extra income each month, a sharpening business is ideal for spare time. The additional dollars can be SPENT for more of the good things of life. Or they can be SAVED in a rainy-day fund that the family can bank on.

**More sharpening businesses are needed every year**

As original equipment continues to climb in cost, owners are becoming more concerned that the equipment be maintained so that it performs like new. This means more companies, contractors, carpenters and home owners are having their old saw blades and tools resharpened many times, where in the past, they would have replaced them with new blades or tools. This is where you can step in with the much needed service of sharpening saws and practically any kind of tool.

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**Shop will gross \$40,000 ...  
... likes being independent**

*"I worked in various industrial jobs for years, and always wondered if I could make money for someone else, why I couldn't do it for myself. So after losing my regular job, I opened my Foley sharpening shop in the basement of my home. I only had a minimum of cash to start with, but Foley financed the balance. My shop will gross over \$40,000 this year, and I like the feeling of running my own shop without answering to someone else."*

William Weacott  
Willoughby, Ohio 44094



**Husband and wife have a going spare time shop**

*"I'm a construction foreman, and my wife is a nurse's aide. Our Foley shop fits in nicely with our regular jobs, and we earn extra money. Our sons help out too, so ours is a real family business."*

*"I'm still too young to retire, but when I do I'll have a very good business built up. Foley equipment helps us to do good work and brings customers back with more jobs on a regular basis ... we have a lot of repeat business the year around."*

Victor Kosloski  
Sturgis, Michigan 49091



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business. It can be yours just for the asking. Right now, while this is still fresh in your mind, fill-in the coupon below. We will send your FREE copy of "Opportunities in a Sharpening Business of Your Own". There is absolutely no obligation and there are no franchise fees in starting your Foley Sharpening Business.

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mends a Michigan retiree, "especially access to the oil filter and sparkplugs."

"They ought to flatten out the floor hump. What's the good of fwd if you have a big transmission tunnel?"—New York cost analyst.

"The liftback glass ought to reach down to the bumper."—North Carolina letter carrier.

A few owners suggested changing the Tercel's styling to make it look more sporting and less tall, but 22.9 percent said specifically that the car ought to be left just as it is.

Of general, unsolicited comments, we set the following aside as representative.

A Georgia clerk-typist: "I looked a long time before finally deciding on the Tercel.

Even though the Rabbit offered better gas mileage, it didn't have the SR-5's sporty looks. The Tercel also beat the four-cylinder Mustang for power. And it beat the Chevette hands down on workmanship. Needless to say, I am very pleased with Toyota and my Tercel."

And finally, these words from a New York restaurant manager: "I believe

## SUMMARY OF 1980 TOYOTA TERCEL OWNERS REPORTS\*

<b>Total miles driven</b> 1,124,763	<b>Specific likes</b>	<b>Very good</b> 37.8	<b>Average</b> 19.0
<b>Average miles per gallon</b>	Economy 72.4%	Good 12.4	Fair 6.1
Four-speed transmission	Handling 48.7	Fair 1.7	Poor 6.1
In town 30.5	Comfort 32.0	Poor 0.0	
Long trips 37.1	Styling 27.6		
<b>Five-speed transmission</b>	Front-wheel drive 19.3	<b>Comfort opinion (rear seats):</b>	<b>Number of vehicles owned:</b>
In town 29.5		Excellent 23.2%	Tercel only 39.1%
Long trips 36.0	<b>Specific dislikes:</b>	Very good 40.5	Two cars 44.6
<b>Automatic transmission</b>	No complaints 35.3%	Good 27.7	Three cars 11.6
In town 24.9	Balky shifting (manual trans) 8.1	Fair 6.8	Four or more cars 4.7
Long trips 30.2	Mpg lower than expected 6.3	Poor 1.8	
<b>Body style and series:</b>	Noise and rattles 5.9	<b>Had any mechanical trouble?</b>	<b>Makes of other cars owned:</b>
Standard two-door sedan 34.8%	Not enough power 5.4	No 61.2%	Ford 23.2%
SR-5 three-door liftback 29.5		Yes 18.6	Chevrolet 20.4
Deluxe two-door sedan 25.4	<b>What changes would you like?</b>		Toyota 15.5
Deluxe three-door liftback 10.3	No changes 22.9%	<b>What type of trouble?</b>	Volkswagen 11.3
<b>Transmission choices:</b>	Improved styling 6.2	Transmission 20.5%	Buick 9.9
Five-speed manual 78.3%	Fewer rattles 3.8	Electrical 9.1	
Four-speed manual 15.5	Reshaped seats 3.8	Shifting 9.1	<b>Age distribution of owners:</b>
Automatic 6.2	More powerful engine 3.8	Fuel gauge 6.8	15-23 years 45.6%
<b>Why did you choose the Tercel?</b>	<b>Workmanship opinion:</b>	Cold starts 6.8	30-49 years 40.1
Economy 72.7%	Excellent 56.0%	<b>Dealer repairs satisfactory?</b>	50-plus 14.3
Front-wheel drive 39.0	Good 36.8	Yes 51.4%	
Price 29.9	Average 6.0	No 48.6	<b>Would you buy another Tercel?</b>
Styling 16.0	Fair 0.4		Yes 93.0%
Roominess 7.4	Poor 0.9	<b>Dealer service opinion:</b>	No 7.0
Toyota's reputation 7.4	<b>Comfort opinion (front seats):</b>	Excellent 36.1%	<b>Would you buy another Toyota?</b>
	Excellent 46.3%	Good 32.7	Yes 95.5%
			No 4.5

\*Percentages might not equal 100% due to rounding or insufficient data.

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PRICES.**

JET-16 Drilling/Milling Machine



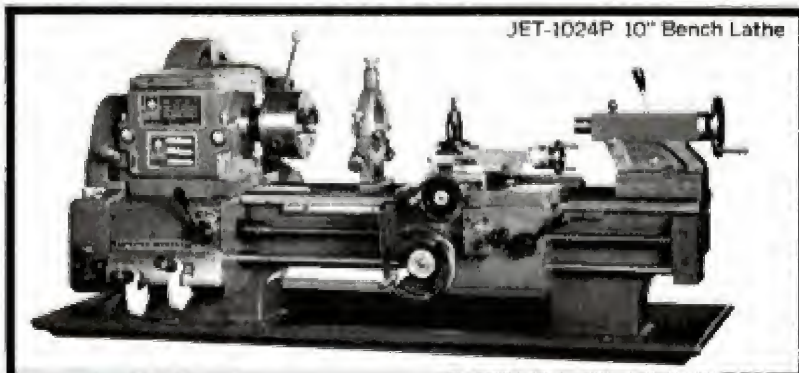
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JET-1024P 10" Bench Lathe



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Toyota makes some of the best values in automobiles today. This Tercel seems to perform well and can accept an awful lot of pounding without complaint. I highly recommend this car to anyone." **PM**



Tercel turns out to be one small car with plenty of legroom for all four passengers.

## The finished product: domestics vs. imports

It's a worrisome fact—brought home again and again in these Owners Reports—that the imports are clobbering our domestic cars in terms of quality and workmanship. We're slipping while they're gaining.

Buyers of American automobiles, even very expensive models like the Cadillac Seville, tell us that they're forever going back to the dealer for attention to problems—usually little things that keep popping off or coming loose or breaking down; oversights that should have been caught at the factory or during dealer make-ready.

Take the Toyota Tercel as a strong case for the imports. Here's a car that's new on the market, with an engine, body and drive configuration just released. The Tercel represents Toyota's price leader; a car obviously built on a budget.

Yet despite the label of being a budget car, the quality is worthy of much more expensive cars. As we mentioned in the report, 81.2 percent of the owners had absolutely no trouble of any kind. And 92.8 percent rated the workmanship good to excellent.

How does that stack up against buyer satisfaction in American cars? Frankly, it's scary. When we queried owners of new Cadillac Seville's recently, 47.2 percent told us they'd experienced mechanical problems (as opposed to 18.8 percent for the Tercel). And only 74.0 percent rated Cadillac's workmanship good to

excellent, compared with 92.8 percent for Toyota.

Now maybe you're thinking this is an unfair comparison because, after all, Seville owners have a right to be picky. Shelling out \$19,000 to \$25,000 gives them that privilege. But recent owner-satisfaction figures for the Chevy Citation, the new Ford Mustang, the Chrysler Newport and others are even worse than for the Seville. So is it any wonder that imported cars now account for 25 percent of the American new-car market?

What are we going to do about this very serious quality gap? There's no simple solution, and the problem deepens, not only as the dollar slips but also as the rift between labor and management widens. We have an adversary system in this country, as opposed to the more cooperative, paternalistic management/labor system in Japan.

One thing, though, *doesn't* show up in any of our Owners Reports and does need to be mentioned. Over the long haul—say 100,000 to 200,000 miles of driving—American cars do seem to hold up better in terms of engine, transmission and driveline longevity.

Owners of well-used domestic cars generally spend less on major repairs like valve jobs, engine overhauls, transmission rebuilds, axle, brake and suspension problems than longtime owners of imports, even expensive luxury imports.—*M.L.*

## Edison introduces the reachable band saw.

A fully functional 10" band saw for less than \$150.

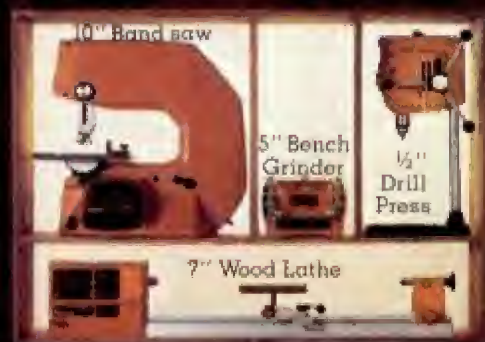
It fits right on your workbench, lifts out of the carton ready to work, and its ½ hp variable speed motor gives you the capacity and precision of stationary band saws that can take up twice as much room and a lot more money.

It cuts everything a good band saw should. Wood, plastics, ceramics and non-ferrous metals.

It's the new reachable band saw from Edison.

Reach for it wherever you buy tools.

And reach a new level of craftsmanship.



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# Home on the



**SUZUKI**  **1980**

## The Performer.

Ride with care. Always wear a helmet and protective apparel. Ride only where authorized and respect the environment.



# range (or road).

Dirt or street, it's all the same to these rugged TS dual-purpose bikes.

This year, all four models (TS-100, 125, 185, 250) come with a sporty new look. And all sport a host of new features.

Some examples: Strong box-type swingarm. Pointless PEI ignition. Easy-grip power levers. Automatic "CCI" oil injection system. MX-styled tank, seat, grips and pegs. And more rear suspension travel.

What it all adds up to is this: They're even more maneuverable in the dirt.

And even more comfortable on the street.

Nice thing is, they still squeeze the dickens out of every drop of gas.





# THIS IS A STICK-UP.

DAP Panel Adhesive is the quick and easy way to stick up wood paneling, drywall and trim. Also perfect for replacing roof shingles, and installing stair treads, risers, subflooring and thresholds. Bonds solidly to wood, plaster, sheet rock and metals. Long lasting. Heatproof. Waterproof.

## DAP

America's Handyman.

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## 'IMPORTS' THAT MADE THEIR MARK AT INDY

(Continued from page 103)

ster. But a stubborn Shaw eventually got his way.

What enchanted Shaw about the Maserati was its road manners. It was nothing like the brutish dirt-track cars of the time. It had independent front suspension with torsion bars instead of springs, a solid rear axle with quarter-elliptic springs and it carried two Rootes superchargers.

In its first attempt, in 1939, the Maserati won—not by sheer power, but by its handling and because it didn't burn up tires as quickly as the American cars. Just to drive the point home, Wilbur Shaw and the Maserati won again in 1940. He was back in 1941 for a third straight 500 win, and almost had it. With 100 miles to go, after leading every lap, the Maserati shed a wheel and crashed. Shaw was taken to a hospital, paralyzed. He was released 10 days later and vowed he'd win again. But he never did.

### Offy dynasty: the rise and fall

The first postwar race was held in 1946 with the field made up mostly of older, prewar cars on their last legs. George Robson took the win in a Sparks-engined roadster. The three Maseratis entered that year came in third, fourth and seventh. The third-place car was Wilbur Shaw's aging Maserati, owned by Boyle and driven by Ted Horn. Shaw was no long racing since he'd become president and general manager of the Speedway when Tony Hulman bought it from Eddie Rickenbacker.

From 1946 until the mid-1960s the Offenhauser engine in the traditional roadster body dominated the

Brickyard. The Europeans virtually ignored the Indy 500, looking down their noses at it as an antiquated form of sport which did nothing to advance the frontiers of racing technology. Critics of the roadsters called them nothing more than updated post-WWI cars.

It wasn't until 1961 when a serious European challenge was issued to the Offenhauser roadsters. Jim Kimberly, a wealthy American sportsman, bought a rear-engine Cooper-Climax, a Grand Prix car, and had it specially fitted out for Indy. It was driven to a ninth-place finish by Grand Prix champion Jack Brabham. While the Cooper didn't break any speed records, it made a spectacular showing when you consider that it displaced a mere 167 cu. in. and produced only 252 hp. The roadsters it ran against produced over 500 hp.

In the 1963 event three rear-engined cars were entered. Two were Colin Chapman's Lotus fitted with a Ford V8 and one was a domestic, built by Mickey Thompson and powered by a Chevrolet engine. Jim Clark in the No. 92 Lotus took second place and Dan Gurney in the other Lotus, No. 93, came seventh. Mickey Thompson's car came in ninth.

The rear-engined cars had yet to win a victory but the handwriting was on the wall. The days of the roadster were numbered.

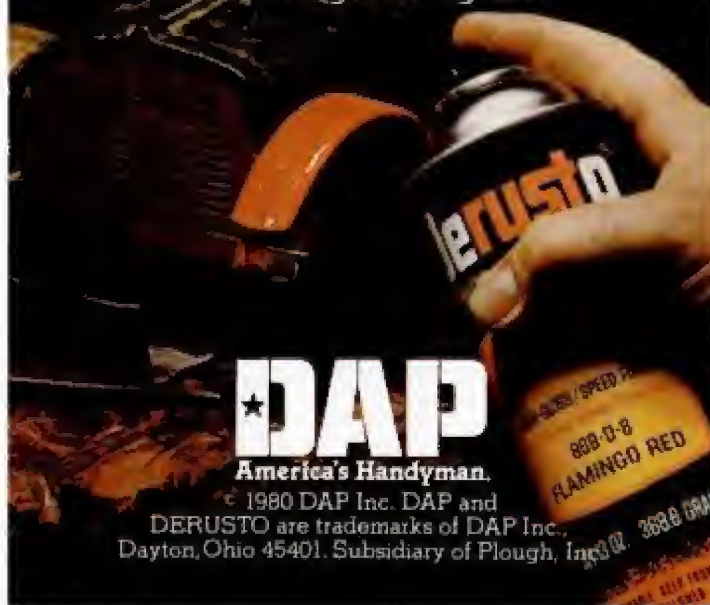
The 1965 running of the 500 convinced even the die-hard roadster fans that the future belonged to the nimble rear-engine cars.

Of the first 10 finishers in 1965, eight were rear-engine cars. Jim Clark in a Lotus took the checkered flag. The roadster was finished. For the first time since 1947 an Offy was not crowned the winner of the Indy 500.

PM

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The state of Nebraska, faced with the same fuel crisis that we all face, put this dynamic method to the test. They used this new fuel in staff cars, trucks, road maintenance vehicles, even state trooper cars (and you know the kind of punishment they take). These vehicles put in a total of two million miles. That's about 80 times around the world. The results? Just too remarkable to be true...but true it is. All vehicles got more miles to the gallon. Drivers reported **faster acceleration, greater engine response.** And the fuel itself measured a **higher octane rating** than premium unleaded gasoline.

The country of Brazil, (as reported in the NY Times), is converting all its cars to run on 100% alcohol...a product that they can produce from agriculture.

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by their inability to assess the damage on the sea floor. The first problem was to locate the wellhead. Divers failed to find it in several attempts. They reported that poor visibility and the tangle of metal on the bottom made the search difficult and dangerous.

On the afternoon of June 6, Pemex contacted Martech International Inc., a Houston-based firm specializing in sub-sea construction and services. By midnight that same day, a team of Martech technicians, a remotely controlled search vehicle called TREC and a load of backup equipment were aboard a Pemex DC-6 headed for Ciudad del Carmen, Mexico.

The TREC (Tethered Remote Camera) search vehicle looks alien to the sea. It's a cratelike metal frame—four feet long, three wide and three high—that supports within it a collection of water-tight modules and electronic packages. It operates from the end of a 1500-foot umbilical, has four small thrusters for movement in any direction and a top forward speed of 2 knots. It's controlled with a small joystick on a console on the surface. The robotic TREC carries its own floodlights and a television camera, and what the TREC "sees" is displayed on the TV monitor positioned at the console.

By noon on June 7, the TREC was ready to go. Its support equipment was installed aboard the work barge *Able Turtle*, which had been positioned at a right angle to the *Tolteca*, nearest the circle of fire. On the TREC's first try, the vehicle had to dive through part of the oil slick, coating the TV lens and making observation impossible. On subsequent dives, Martech launched the TREC from outside the surface slick.

### The Turtle enters the fire

Close to the bottom, it was flown in side-to-side sweeps in a planned search pattern. For each sweep, more of the umbilical cable was let out, until it finally had reached its end. To allow for further sweeps, the two barges were moved closer to the fire, ultimately so close that the *Able Turtle*'s blunt bow extended into the flames.

The deck temperatures rose to 145° F. The crew rigged hoses to sprinkle the deck, allowing the bargemen, Martech technicians and diving crews to continue working despite the flames.

Hour after hour, the Martech technicians maneuvered the TREC

(Continued from page 109)

and monitored the pictures it sent back. In the round-the-clock search, visibility was limited by the 15-foot reach of the TREC's lights. Debris on the bottom also hampered the search. The TREC had to be flown carefully to avoid getting snagged as it threaded through the jungle of drill pipe and pieces of gear beneath the waves.

Finally, at midnight, Friday, June 8, the TV monitor showed a maze of debris ahead. The TREC flew closer, and its lights picked up a long section of riser pipe thrusting up from the sea floor. TREC followed the pipe around a 45° bend. Suddenly its lights picked up the 40-foot BOP stack, oil pluming upward from its top. After 14 hours, the search was over.

Though divers could now find their way to the wellhead, there was still work for the TREC. The vehicle flew around the BOP to make a damage survey. The operator tried to avoid the blast of oil from the stack, but he maneuvered the TREC too close to the high-pressure plume of crude and gas.

The cone-shaped vortex grabbed the TREC and shot it to the surface. The turbulence wrecked its electronic and depth-compensator packages. It took 12 hours to replace them with spares.

### The runaway well

While the TREC was being resuscitated, a diver went down with a handheld TV camera to examine the BOP. Though it leaned over about 10 to 15°, it didn't appear seriously damaged. Red Adair's team and Pemex engineers found some encouragement as they studied videotapes of the stack. They figured that the BOP would probably function again with the replacement of hydraulic-electric control pods that opened and closed the valves. They also planned to install new choke and kill lines, pipes that can be used by experts to pour cement, killing a wild well.

But the runaway well was not to be easily tamed. To start with, strong bottom currents and rough seas, with 10-foot swells rocking the barges, slowed divers' work. Then the wellhead developed another leak. It was impossible to fix the BOP. Fire continued to burn on the water. On July 4, another attempt to use the BOP was made. It failed to halt the blowout.

Faced with an oil spill that was growing worse daily—and threatening to devastate the Mexican and American Gulf coasts—desperate



Pemex officials hit trouble regardless of what they tried.

■ They began drilling relief wells. They positioned two drilling rigs on opposite sides of Ixtoc 1, each about half a mile away. Wells were to be drilled at angles to intersect Ixtoc 1 at a depth of about 12,000 feet. But with a downhole target of some 100 feet to shoot at, this calls both for technical sophistication and the dead aim of a Robin Hood. The drilling was agonizingly slow.

■ Using the choke and kill lines hooked into the BOP, they injected tons of two-inch metal balls—80,210 lead balls and 27,550 of steel. The principle made sense: In a rising column of liquid or gas, the balls induce friction in the fluid, slow the flow and reduce its pressure. The experiment reportedly cut the flow in the well from 30,000 barrels a day to 10,000. But some experts discounted this, saying that the balls simply may have forced a lot of oil out through cracked casing at a lower level.

■ Next came "Operation Sombrero." Resembling a large, inverted funnel and measuring 40 feet across at its mouth, the 310-ton "sombrero" was hung some 10 feet above the top of the BOP. The theory behind it was simple. Oil and gas from the well would flow up into the funnel and up through a pipe to a point where the oil could be separated from the water and the gas burned off. The collected oil would be offloaded into tankers.

But, at least initially, Pemex didn't get much wear out of its sombrero. Soon after the collector was in place in September, heavy seas damaged the support bracket. The device was pulled up and returned to Texas for repairs.

Despite all these efforts, by early December, the well had poured approximately 2.5 million barrels of oil into the Gulf, far surpassing the previous world's worst spill, the 1.3 million barrels dumped in the grounding in 1978 of the *Amoco Cadiz* off the coast of France. And current had carried much of the oil from the new spill northward toward Texas.

### Tracking the 'enemy'

The U.S. National Response Team—comprising Coast Guard, Navy and Department of Defense representatives, among others—tracked the oil as if it were an invasionary force. The defense strategy: to protect lagoons behind the islands strung along the Texas coast from Brownsville north to Galveston. The barrier islands—Mustang, Padre and others—were natural shields, if the invading oil could be stopped at the passes between the islands.

In the days following the initial rupture, U.S. planes flew broad search patterns, looking for oil. Long-range eyes were provided by Navy P-3 Orion submarine hunters, and by Coast Guard C-130s. The big-bellied C-130 carried the Coast Guard's Airborne Oil Surveillance System for mapping oil patches. Sidelooking radar and a passive microwave imager probed the sea surface up to 25 miles on either side of the aircraft. Smaller and with a shorter range, a twin-engine Buffalo was used for closer, low-altitude missions, such as shoreline surveys.

### Chocolate in the surf

By late July, the Texas shore remained clean. Then on July 31, the crew of the Buffalo reported seeing heavy oil deposits along Mexican beaches, and chocolate-brown oil-water emulsion awash in the surf only

(Please turn to page 261)

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## WORLD'S WORST OIL SPILL

(Continued from page 259)

60 miles south of Brownsville.

The Coast Guard Strike Team—pollution-fighting experts with very specialized equipment—mobilized quickly against the dark tide. Soon oil skimmers, miles of floating boom and other heavy gear were aboard C-130s or on flatbed trucks, heading from other states to Texas. The defense line was in place when the oil reached Brazos Santiago Pass near Brownsville.

## War casualties

In terms of logistics, intelligence gathering, strategy planning and the deployment of manpower and equipment, fighting the Bay of Campeche oil spill was like waging a small war. But how effective was it?

Preliminary figures from the National Oceanic and Atmospheric Administration (NOAA) indicate that the spill affected approximately 140 miles of Texas coastline, from Brownsville to about 15 miles north of Port Aransas. In all, about 3 million gallons of oil hit the beaches. When the spill was at its worst, from 8 to 10 percent of the Gulf's surface was covered with oil. Overall, though, the strategy worked: Lagoons were only lightly hit.

## The meaning of Ixtoc

For another assessment, I called Pemex in Mexico City. The battle was still on, a spokesman told me. One relief well had been drilled to 11,942 feet, the other, 12,070 feet. As yet, neither had hit the target. The sombrero was no longer in place because it was "in for repairs," he said. The well was leaking some 2000 barrels a day, "some of which is burned, some recovered." (The figure quoted is far too low, say American oilmen, who see little improvement at the well.) His general assessment: some progress, much frustration.

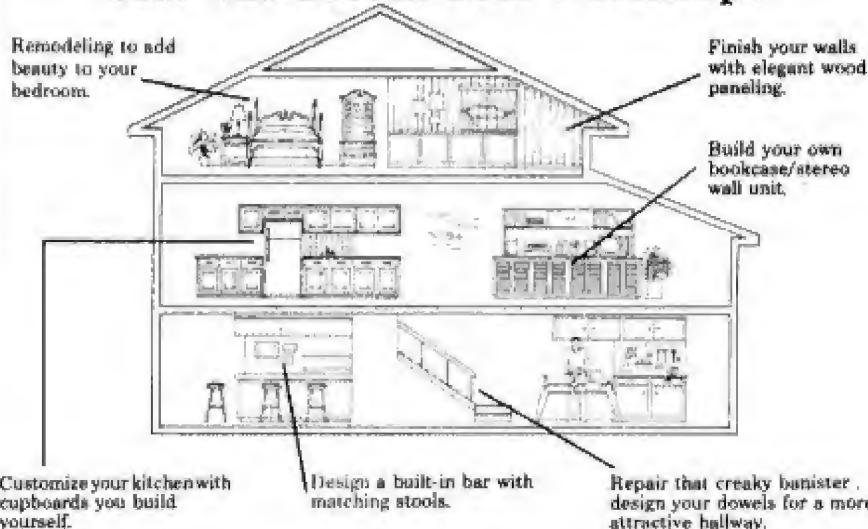
But the Pemex spokesman couldn't hold back a laugh when I asked my last question: Does the name Ixtoc have a meaning?

"It sure does," he said. "It comes from the Mayan and it can mean 'to blow out.' You might even translate it as 'the damn blowout.'"

Ixtoc 1 has more than lived up to its Mayan name. **PM**

At press time, the Pemex spokesman said relief drills had finally reached the target area. The company was "just about ready" to seal off the well, he said, but bad weather continued to blow over the Gulf, delaying the work. And the oil on the water over Ixtoc 1 continued to burn.

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(Continued from page 94)

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### Star of the show

Auto shows can really be fun when manufacturers bring more than their current-model-year crop of cars. Alfa Romeo did just that for the New York show, recently. The Italian sports-car and sports-sedan manufacturer rolled in with its Spider Veloce, Sprint Veloce and Sports Sedans, but also in tow was one of the grandest roadsters ever made. The pre-World War II Alfa, designated 8C-2900B, is powered by a su-



**Straight Eight powers this Alfa Romeo.**

percharged version of the company's 2.9-liter straight Eight that was produced during the '30s. The car hasn't gone far on its own, but it's sure seen the world: The roadster, now worth some \$200,000, was built in Italy for an Indian maharajah, found its way to Australia and finally to the United States.

### World of modeling

Not all motorsports events are run in full scale. Some competitions are 1/24-1/25, 1/16, 1/14, 1/12 or 1/8-scale. There's even a land speed contest scheduled for fans of AFX slot cars. This is one of several participation activities for modelers that's sponsored by Auto World and described in its new catalog. In the pages are such interesting listings as a radio-control motorcycle. More traditional models include plastic and die-cast metal designs of passenger, sports and racing cars and trucks. There are also Auto World's 1980 model car catalog. modeling accessories and how-to books dealing with the world of modeling. The 136-page catalog is available for \$1 postpaid from Auto World, 701 North Keyser Ave., Scranton, Pa. 18508.



**Auto World's 1980 model car catalog.**

PM





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With our optional 110 volt adaptor you'll also find endless uses wherever house current is available... at your cottage... as a bar fridge... in your motel room for a midnight snack and drink... as a small office fridge... or beside your pool. Use as an auxiliary home fridge when you're having a party.

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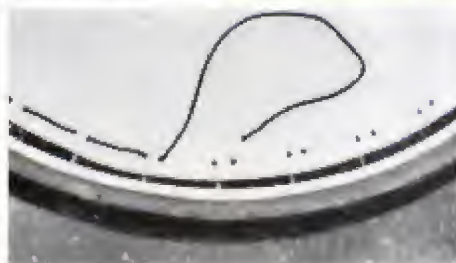
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## POLAR SUNDIAL (Continued from page 130)

should also be considered. This can be found in the same sources from which you obtained the latitude. Add four minutes for every degree of longitude that you live west of the center meridian in your time zone; subtract four minutes for every degree that you are east of this line. The center meridian for Eastern Standard Time is west longitude 75°; CST, west longitude 90°; MST, 105°, and PST, 120°.

Your sundial should be placed on a level table or stand. Point the gnomon true north by rotating the dial until the edge of the gnomon shadow points to your watch time. Then shift the shadow reading to compensate for the date and longitude corrections given above.—John S. Lorr

## BICYCLE CART (Continued from page 132)



Bore two holes per spoke and lace on polyethylene guard, cut to fit inside the rim.

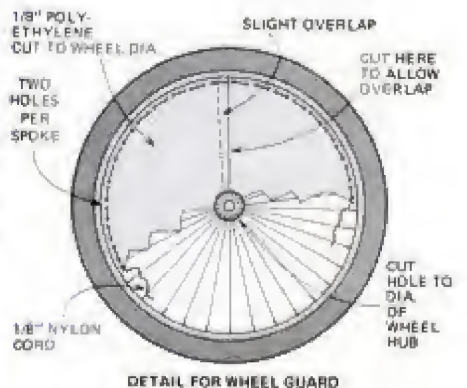
light because the load weight is evenly distributed over the wheels. The result is free and easy pulling.—J.H. Brennecke

PM editors suggest that you add three safety features to the bike cart: a wheel guard to protect fingers from moving spokes; a retaining belt to re-

## SUNDIAL CORRECTION

Here are the number of minutes that must be added or subtracted from sundial time to arrive at standard time on dates given.

DAY	MIN.	DAY	MIN.	DAY	MIN.
Jan.		May		Sept.	
1	+3.5	1	-3.0	1	0.0
10	+7.5	10	-3.7	10	-3.0
20	+11.0	20	-3.6	20	-6.5
Feb.		June		Oct.	
1	+13.5	1	-2.5	1	-10.0
10	+14.5	10	-0.8	10	-13.0
20	+14.0	20	+1.3	20	-15.0
March		July		Nov.	
1	+12.5	1	+3.5	1	-16.3
10	+10.5	10	+5.0	10	-16.0
20	+7.5	20	+6.2	20	-14.4
April		Aug.		Dec.	
1	+4.0	1	+6.2	1	-11.0
10	+1.4	10	+5.3	10	-7.2
20	-1.0	20	+3.4	20	-2.5



mind kids to stay put, and a caution sign (see details above). When pulling a loaded cart, go slowly and don't make sudden stops.—J.P.

## SUPER SWING SET (Continued from page 133)

(slide side) to ground stakes should remain until the roof sheathing is in place. Frame the swing set as shown in the plans.

Note that swing-support headers are pinned to header joists. Bore 3/8-in.-dia. holes in these joists and insert 3/8-in.-dia. steel rod. Bore matching holes in the support header and slip it over the pins. Heavy-duty 5-

in. corner braces can also be used in place of pins.

### Building the slide

The foot of the slide must be securely anchored to a concrete base, since this will prevent the A-frame from swaying. Prepare a form and locate anchor bolts for securing the

(Please turn to page 266)



## Learn Glass Etching



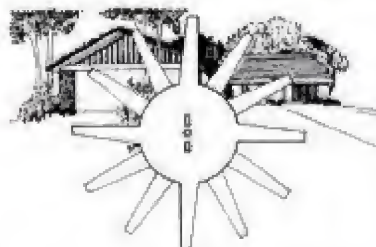
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Opposite view shows sliding board made of heavy-gauge, galvanized sheet metal.



Hand-over-hand climber was made from a discarded wood ladder with round rungs.

### SUPER SWING SET (Continued from page 264)

slide to the base plate. After the concrete has been poured and allowed to set, the slide rails can be attached. Notice that the rails are built in three sections. Use 3/4-in.-dia. x 3-in. carriage bolts to join them together and counterbore so threaded ends of bolts don't snag children.

Secure the top end of the rails to the 2x4 loft joists. Use a mending plate and No. 10 rh screws or bolts. Fasten the rails to the slide base plate after it has been secured to the anchor bolts in the concrete.

Next, build the bottom end of the slide. The underside of the lower rail boards are curved at one end. Use the lid of a 20-gal. trash can to mark the arc before cutting.

Now attach the galvanized sheet metal to the underside of the slide rails. Use 1/4-in.-dia. x 1 1/2-in. lag-screws with washers. The metal edges should be recessed about 3/4 in.

from the rails' outer edges. Leave enough extra metal at top and bottom so it can be wrapped under the cross members and then fastened securely with more lagscrews. When using two or more pieces of sheet metal, make certain that the upper section of metal will overlap the lower one by at least 3 in. Add cross-member supports under each sheet-metal joint.

On the opposite side of the A-frame install the fireman's pole. Sink it at least 1 ft. into the ground or into a concrete footing. Attach the top to the ridgeboard with metal strapping. Additional accessories, as shown in the plans, can be added at your discretion. Use 3/4-in. nylon rope or chain to hang the various ladders, swings and trapezes.

Finally, check for splinters (especially on the slide rails) and protruding bolts before letting the kids loose.—Charles R. Hentz



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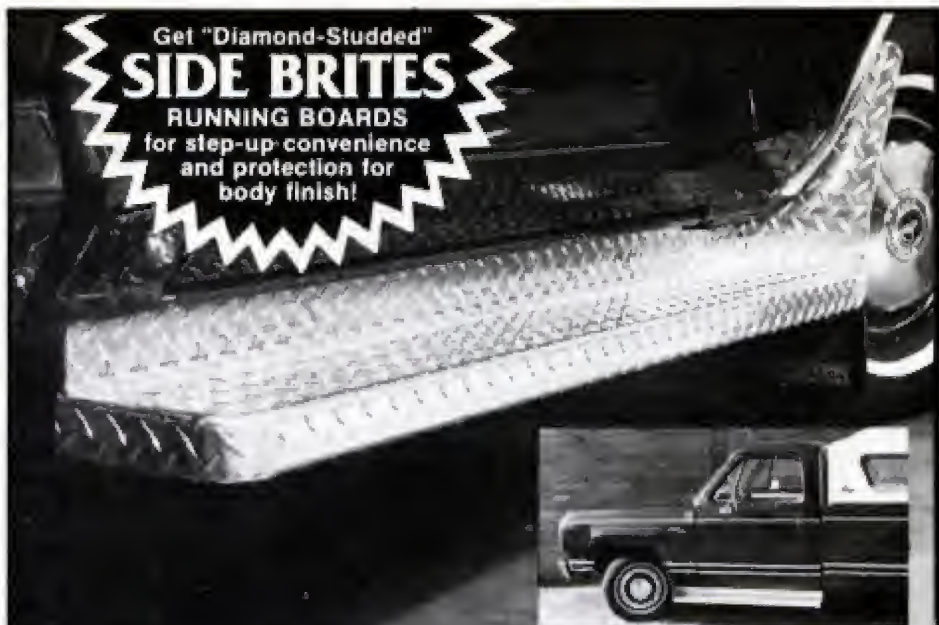
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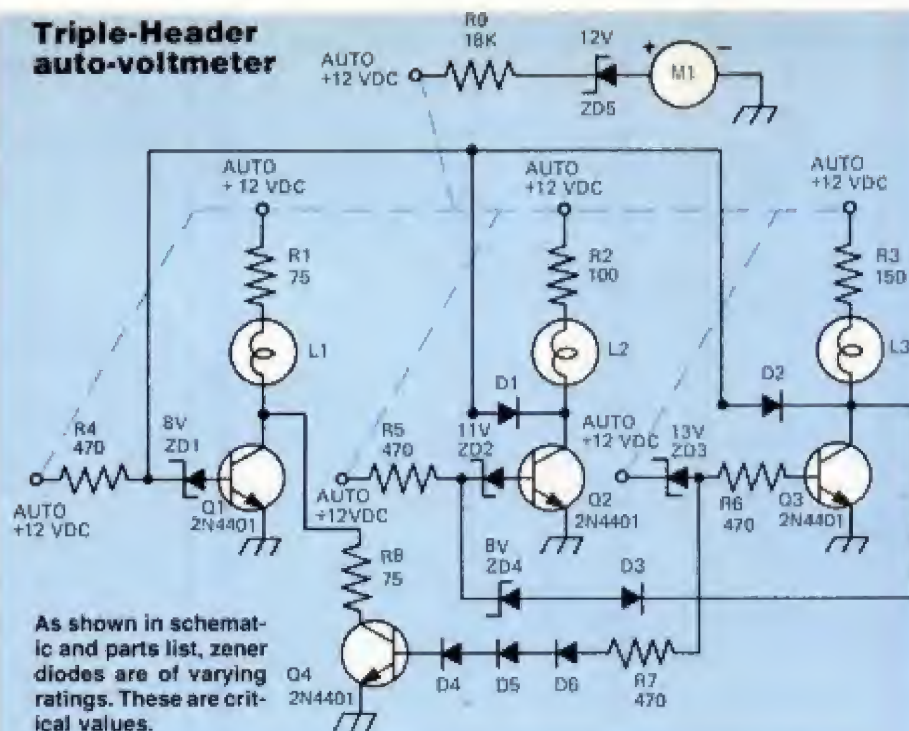
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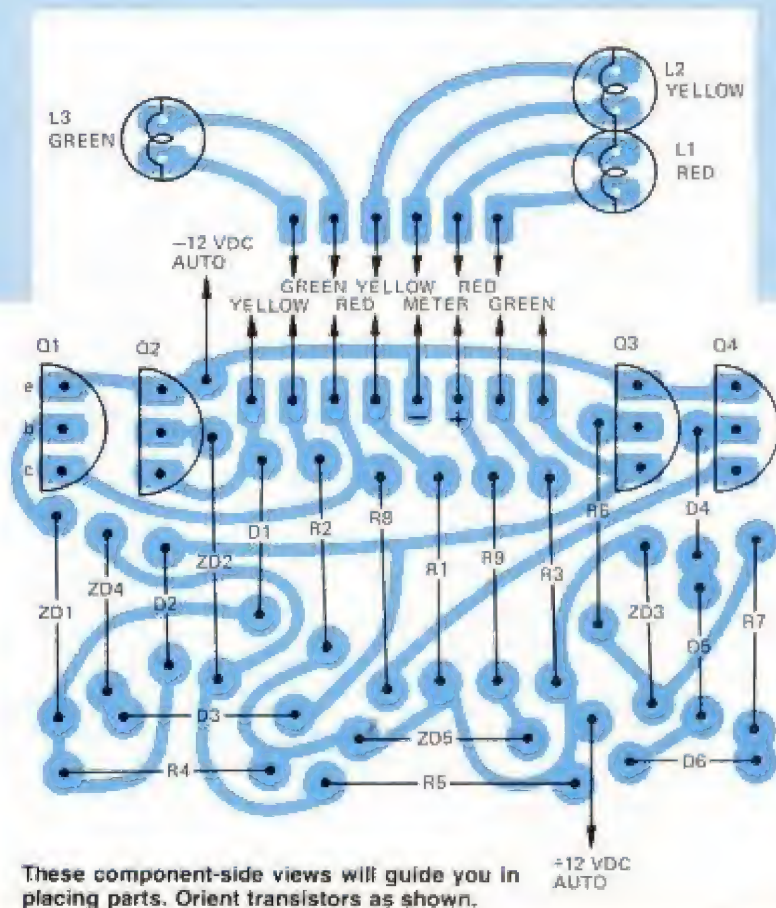
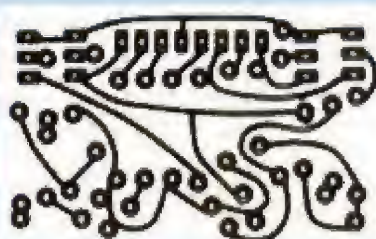




## Triple-Header auto-voltmeter



Use these templates to make a meter PC board (above), and a main board (right).



## BUILD THE 'TRIPLE-HEADER'

(Continued from page 42)

volts, a voltage it never could maintain if it were putting out hundreds of amps. to crank the engine. Conclusion: The starter isn't receiving or drawing any current.

If the solenoid "clicks in," then the starter could have bad brushes or an open spot on the commutator and/or the connections to the starter could be corroded by road grime and salt. If the problem isn't in the starter, then the solenoid contacts are most likely worn out.

If the solenoid doesn't "click in," then either it is defective or the ignition wiring is bad. To find out which, bridge the solenoid as though you were going to "hot-wire" the car. If it cranks, the ignition switch or wiring is defective.

Another case: You crank the car and it turns over very slowly or not at all. All the lights on the scale are out, so you know that there's less than an 8-volt output coming from the battery.

Check the battery connections. If they're okay, then the problem is a dead, discharged or out-of-water battery.

## Running difficulties

If the red or yellow lights glow when you are moving at highway speed, *immediately* check the fan belt. It's amazing how often it turns out to be the sole problem.

The meter falls rapidly and the red light eventually comes on. "Racing" the engine to get "extra power" from the generator/alternator doesn't slow the downward fall of the voltage one bit. Adding any electrical load (such as lights) accelerates the voltage fall.

The battery supplies the total needs of the car. It's just a matter of hours (or less) until it is dead. Once that happens, you're stuck.

There are procedures for finding

(Please turn to page 270)

## PARTS LIST—TRIPLE-HEADER

- R1, R8—75-ohm resistor
- R2—100-ohm resistor
- R3—150-ohm resistor
- R4, R5, R6, R7—470-ohm resistor
- R9—18,000-ohm (18K), 1/2-watt, resistor
- Unless otherwise shown, all resistors are 1/2-watt, 5% tolerance.
- L1, L2, L3—6-volt, 70-ma. lamps; red, green, yellow
- Q1, Q2, Q3, Q4—2N4401 NPN transistor
- M1—200- $\mu$ A edge meter
- D1, D2, D3, D4, D5, D6—1N4148 diode
- ZD1, ZD4—8-volt zener diode, 400-mw.
- ZD2—11-volt zener diode, 400-mw.
- ZD3—13-volt zener diode, 400-mw.
- ZD4—12-volt zener diode, 400-mw.
- Mtc.—case (Pomona 2104); PC board materials; wire and ribbon cable; solder.
- Note—A complete kit of parts is available from Circuit Craft Inc., 10 Idell Rd., Valley Stream, N.Y. 11580. Kit sells for \$16.95, or completely assembled and tested for \$24.95. Meter is available separately for \$2.95.



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## HOW CAN WE DO IT?

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UTP Ion Research Center is a branch of our educational publishing company. And our commitment in publishing to give birth to new ideas and methods that enrich humanity is part of the Ion Research Center too. We're in business to serve you and your environmental needs.

## WHAT ARE IONS?

Ions are electrically charged atoms in the air with either a positive or negative charge. The sun and cosmic rays as well as lightning and fast-moving water (like waterfalls, surf) generate trillions of negative ions every day. The more negatively ionized the air, the fresher and more alive it is. Air pollution, artificially controlled climates (with air conditioning and heating) and electronic equipment all produce excess positive ions, depriving the air of these small negative air ions and creating dead "stuffy" air.

## WHAT'S THE SOLUTION?

Our rapid-growth technology, which sometimes takes its toll on the quality of our air, has also come up with the solution. Following Nature's model of the thunderstorm which uses a high electrical charge to purify, revitalize and stimulate the air, the UTP Air Energizer has been developed imitating this process. Both the thunderstorm and the Air Energizer fill the air with negative ions, restoring the natural electrical balance to the polluted, energy-depleted air. But the Ion Fountain can be used indoors in the home, office, workshop, laboratory, etc., keeping a fresh supply of ionized oxygen available night and day. This new breakthrough in fresh air control is not a cover-up

which masks or deodorizes. The unit actually removes the dust, smoke, bacteria and pollen particles from the air by attaching ions to them and causing them to sink to the earth where they can be vacuumed up rather than inhaled. At the same time ions electrically stimulate the energy-stripped air.

## YOUR CHOICE OF TWO TOP-QUALITY UNITS!

There's only one unit that's better than the Ion Fountain. That's our own Executive System Four™. It sells for \$159. It has an even higher ion output. Plus! Our special **Dial-A-Ion** feature allows you to adjust the ion output anywhere from low to high. Not everyone knows that the need for ions varies. A large smoky room will require higher output than a small room. And some people want fewer ions while sleeping than while working. The new Executive System Four is our answer to this need for output flexibility.

## FACTS YOU NEED TO KNOW

### The Ion Fountain™—System Five

<i>Ion density:</i>	430,000 ions per cm <sup>3</sup> /sec. at 1 meter. 1.55 million ions per cm <sup>3</sup> at 50 cms.
<i>Use:</i>	Large room or office—9000 cu. ft.
<i>Warranty:</i>	1 year
<i>Output voltage:</i>	15KV
<i>Ozone:</i>	Less than 2 parts per billion
<i>Dimensions:</i>	5 1/2" x 4 1/4" x 2 1/2"

### Executive System Four™

<i>Ion density:</i>	Low to maximum of 540,000 ions per cm <sup>3</sup> at 1 meter. 1.6 x 10 <sup>6</sup> ions per cm <sup>3</sup> at 50 cms.
<i>Output voltage:</i>	15KV
<i>Ozone:</i>	Less than 2 parts per billion
<i>Dimensions:</i>	11" x 5" x 4"
<i>Use:</i>	Large room or office 10,000 cu. ft.
<i>Warranty:</i>	1 year

If the Executive System Four is better, why did we bring out the Ion Fountain? Not everybody is willing to pay \$159 for an air ionizing unit, no matter how good it is. Just like not everyone drives Rolls Royces. Most drive less expensive cars. The Executive System Four is for the person who wants the

absolute best quality and doesn't mind paying a little extra to get it. If you want highest ion output, flexibility, and a beautiful oak paneled case, buy the Executive System Four.

If you want something at half the price of the Executive System Four, but still better than any other units costing up to \$250, buy the Ion Fountain.

## HOW TO GET ONE

To place your order now just send a check for \$79.95 plus \$3 shipping for the Ion Fountain. Or send \$159 plus \$4 shipping for the Executive System Four. Tell us your full street address as we cannot ship to Post Office boxes. (California residents add 6% sales tax.)

Our unit is dependable and trouble-free, but if by rare chance any problems occur our service-by-mail center sends off your unit within 24 hours of receipt or sends a replacement so you are not without fresh air and can enjoy your dust-free environment. And each Air Energizer is backed by a full one-year limited warranty.

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## BUILD THE 'TRIPLE-HEADER' AUTO-VOLTMETER

(Continued from page 268)

out whether it is your voltage regulator or generator/alternator that is at fault, but you have to check a service manual for your car to find the exact details.

Suppose that under light electrical loads the voltage stays in the 13.7 to 14.7 range, but it falls off sharply under heavy loads, and voltage snaps back when load is removed. What's happening is that when you exceed the limited capacity of the generator/alternator, the car goes on battery power and the voltage falls.

If you have a generator, this situation generally results from bad brushes or a worn and dirty commutator. If you have an alternator, the brushes may be bad, or some (but not all) of the diodes may well be in poor condition.

### Overcharge

Both the Triple-Header's red and green lights glow at the same time during overcharging. This is the only situation where two lamps glow. The meter will be over 14.7, perhaps right off the scale.

Almost invariably the voltage regulator is at fault. Replace it; you'll avoid burning out light bulbs and shortening battery life to a great extent.

### Undercharge

The voltage is stable and well regulated, but at too low a level. You never get above 13.7 volts and the yellow light is on all the time. The lower the voltage, the more severe the problem.

Though nothing in the car is likely to be damaged, the battery will never get a full charge, and you may conceivably have some trouble cranking the car.

Replacing the voltage regulator will cure this problem.

### Weak battery

As a battery gets older, its internal resistance rises and, as a consequence, it is less able to hold up its voltage under load.

Shut off your engine and then turn on the headlights. The voltage will fall about ½ to ⅓ volt. If it falls more, say a volt, it's probably getting old, particularly if the voltage drop is more than it used to be.

### Shorted battery

When one of the six cells is shorted or defective, the battery can't maintain its open-circuit voltage.

Make sure the battery is charged by riding with the Triple-Header

showing green for a half hour or so. Then shut off the car for an hour. Come back and turn on the ignition. Do not crank the starter. If you don't get a meter reading, and the red light is on, it's likely you have a shorted battery, especially if the car won't crank.

### Dead battery

When you turn on the ignition without cranking, the voltage will be very low. Depending on how discharged the battery is, it could be anywhere from 0 to 12. Once you get the car started and run it for a while in the 13.7 to 14.7 range, the battery will recover rapidly. Within a day or two of normal driving, the battery will be back to normal.

### Glowing red—bad news!

The Triple-Header can spot those emergency situations which require immediate attention to prevent either engine damage or total electrical failure.

The red light comes on, and stays on (same as defective alternator) when you are moving along over 30 mph.

Stop the car right away to see if the fan belt is broken or loose. Usually, both the alternator and the water pump are driven by this belt. It won't take the engine long to overheat without the water circulating. If it gets hot enough, it can seize, and then you'll find yourself in the market for a new engine or, perhaps, even a new car.

But, even if the fan belt is at the proper tightness, you are still in big trouble. The car is running on the battery, and it won't last much longer before it is out of juice. Since the alternator isn't supplying anything when the battery gives out, your car stops dead (remember, the ignition coil runs on electricity). Once the battery is dead, the car won't even crank.

### Building your own

At the heart of the Triple-Header are three zener diodes. A zener diode will not conduct until its threshold voltage is reached.

These zeners act as "switches" to turn on the lights at specific voltages—the red light at 8 volts, yellow at 11, green at 13.

You can fashion your own PC board with the guides we provide, or buy your Triple-Header as a complete kit, or even assembled. Check the parts list for prices and availability.

Good luck—and go on green! **FM**



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### Develop your body to its fullest potential!

Not everyone can develop massive muscularity as shown here. Of course, there are some who can exceed it. But it is important that you know that everyone can develop to his maximum potential! With bodybuilding, you can get into shape. Really into shape! With the right amount of effort, you might even make the girls notice you with admiration and make a few guys turn their heads in envy.

Besides looking better, when you get into shape, chances are you are going to feel better and have much more energy. That's how much bodybuilding can do for you. All you have to do is follow our program three times a week. And each bodybuilding session can probably be completed in the time it would take you to drive to a commercial spa and back. What's more, you can follow our program in the privacy of your own home.

### Get a sexy, trim and muscular waist!

Ask any girl what the biggest turn-off is in a guy's appearance. Chances are, she'll say FAT. However, with the proper combination of bodybuilding and diet, you can get rid of excess fat and flab. You'll see miracles performed on your waistline!

### Want to do better in sports?

It's a fact! With all other factors the same, the stronger guy almost always out-performs the underdeveloped, weaker guy. This is the reason most coaches put their athletes on a strength building program. And for you, this is where the Universal Bodybuilding program comes in. Because not only can it help you get into shape, it can improve and increase your strength as well!

### So, why let yourself deteriorate?

Face it. Unless you do something about it, your body will eventually become out of shape. Participating in sports will help, but as you get older, it is difficult to remain as active as you would like to. However, unlike most other sports, bodybuilding is a sport that you can continue at almost any age. In fact, there are bodybuilders who are in their 30's and 40's who are more muscular than most Olympic champions! With progressive bodybuilding, you get results you can see and feel!

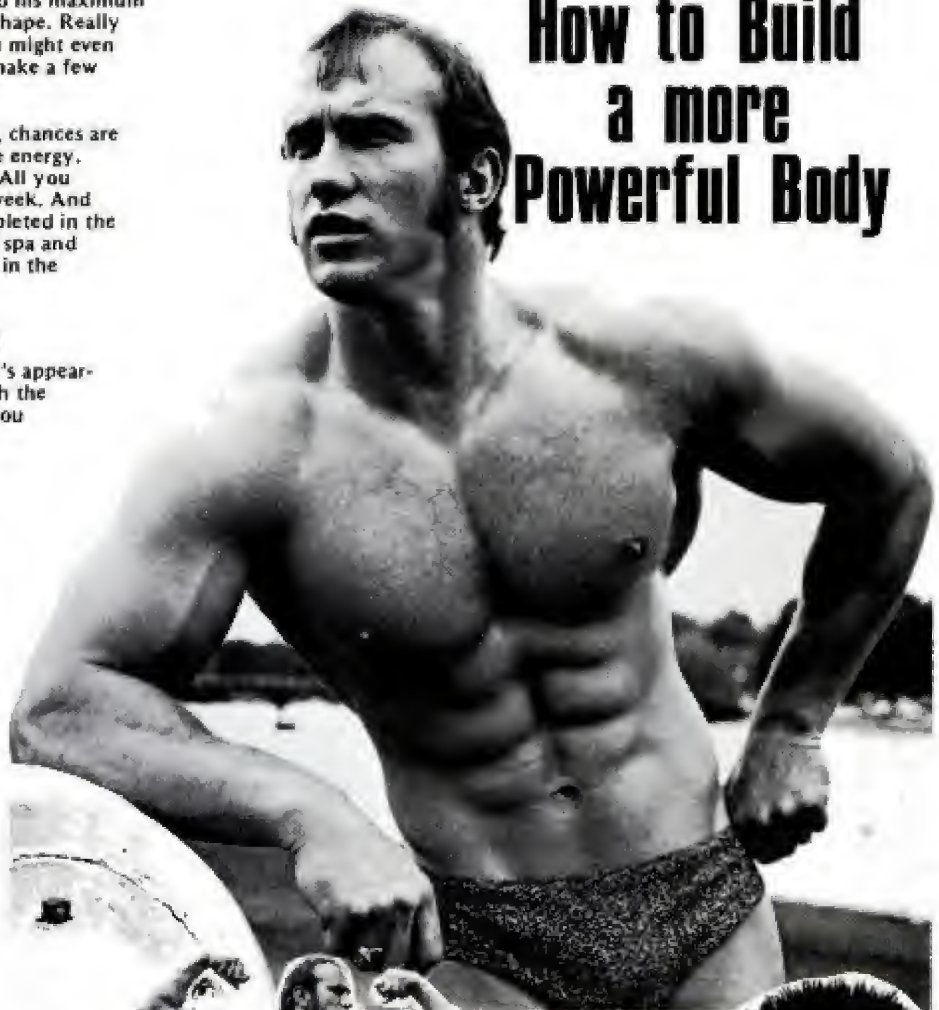
Also, don't forget the psychological benefits of exercise. As you get into the habit of exercising, you'll have an increased awareness of self, and being more in touch with your body!

### Only for the healthy!

Before embarking on this bodybuilding program, or any other new physical endeavor, be sure to check with your physician for his okay. A bodybuilding course such as this specializes in developing the body to its maximum potential and should only be attempted by those in good health.

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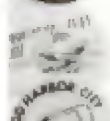
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## NEW BUDGET BOATING SHAPES

*(Continued from page 127)*

powerboatmen will accept radical speed reductions which limit their cruising and fishing range, water skiing and the rest. The trick is to create a boat which will use considerably less fuel at speeds which are still acceptable—say 20 to 25 mph for the average runabout or small cruiser.

One of the most significant innovations in fast planing hulls has been the deep-vee design. I helped



With enough power, a deep-vee hulled boat like this Silverline Nantucket 24V planes while keeping its wave-cutting ability.



Cruisers' Holiday 22 also uses a "Double Deadrise" vee hull and sterndrive power for less wetted-surface-resistance ride.

develop it in offshore marathon races in the 1960s, and recent improvements have refined it to give an excellent combination of comfortable dry ride in choppy water, good stability, easy handling and safe, smooth maneuverability. In a typical stern drive or outboard boat, the vee angle (deadrise) is 18° to 24° at the transom and remains fairly constant halfway forward.

In more recent designs, the angle is sharper near the keel (center) and flatter near the chine (outer edge). This provides a sharp entry for smoothing choppy water, but the flatter portion improves stability and low-speed planing characteristics. Used in Silverline's 24-footer Nantucket and Cruisers' Holiday 22, we call it a "Double Deadrise."

While the deep vee has proven ide-

al for fast-planing boats, when we slow down to save fuel, a bottom with less deadrise will plane more efficiently. The ultimate would seem to be a nearly flat bottom, but this would be unacceptably rough riding in anything but flat, calm water. As usual, a compromise is in order; by keeping the forward part of the bottom quite sharp while reducing the deadrise at the stern to about 12°, riding comfort seems to be almost as good as the deep vee up to about 25 mph and considerably less power is required.

Such a new design is being tested in a 7.5-meter (25-foot) craft recently introduced by Albin Marine in Sweden. Just as foreign auto manufacturers pioneered fuel-efficient cars, the same may happen with boats. Gasoline is approaching \$3 per gallon in Scandinavia and diesel fuel is only one-third as expensive, a situation that may develop in the United States. Albin chose a small, lightweight Swedish diesel to power its economy design for the European market. The combination of hull design and Volvo-Penta's new 124-hp turbocharged Six is expected to give nearly 50 percent more mpg than comparable-size boats with gasoline power.

We tested this engine when PM's boating editor and I made a run from Miami to Nassau (PM Test: *Little New Diesel for Little Boats*, page 84, Feb. '78). Our single-engine, 24-foot AMF Crestliner used only 54 gallons of diesel fuel for the 180-mile trip at an average speed of 24 mph.

It was a cold, windy day in Sweden last October when we ballasted the prototype Albin 7.5 hull to simulate the weight of the finished boat with full load of equipment and tested it for the first time. The boat did over 25 mph, but more important, it



Props positioned in "Propeller Pockets" of a Phoenix 27 cruiser hull are protected, more level and have efficient shaft angle.

started to plane at about 12 mph and ran easily in the 15-to 20-mph range with very little power. The interior is planned by industrial designer Fred Hudson as a compact family cruiser, with berths for four in two separate cabins. The craft was dry and comfortable in rough conditions



during the testing, and should be suitable as well for skiing and family water sports.

Another important economy factor is the efficiency of the propulsion system, especially the propeller. Other things being equal, there is an optimum size and rpm for a propeller for the best power and boat speed. In general, a faster boat should have a relatively small high-speed prop, although acceleration and load-carrying ability also affect this selection.

The inboard-outboard (I/O) came into its own during the 1970s for boats from 16 to 30 feet, particularly in deep vee hulls for speeds of 25 mph and up. It was a trend that started with the Volvo-Penta stern drive which I helped develop in the early 1960s, and provided power and weight well aft for an ideal planing angle.

Efficiency at lower speeds, however, can be improved with a larger diameter propeller than I/O units can accommodate, and a conventional, inclined-shaft inboard system, with suitable reduction gear at the engine, appears suitable in certain applications. On a small boat, however, a large propeller requires the engine to be placed well forward to prevent excessive shaft angle, but the engine then takes up too much cabin space. Several years ago we worked out our "Propeller Pocket" system, where the hull above the props is recessed to allow more diameter and normal shaft angle. It has proved successful on a number of production Wynne Marine design boats built by Cruisers, Phoenix, Slickcraft, Robalo and Albin.

#### For the future

For the coming decade, runabouts and cruisers will undoubtedly be designed to operate at slower, but effective, planing speeds. The bottoms will have less deadrise and other refinements to reduce power consumption. Lighter weight boats will evolve, but I see no affordable miracle material on the horizon. A new generation of small turbocharged lightweight diesels should arrive for boats over 22 feet. For smaller craft, outboards and I/Os with lightweight powerplants from the new, smaller cars, some turbocharged, should be successful.

Tomorrow's boats will have to be not only fuel-efficient, but also practical and functional. Today's boatmen are more knowledgeable and experienced than ever before, and will be looking for top quality. And more newcomers will find boating the ideal answer for "getting away from it all."

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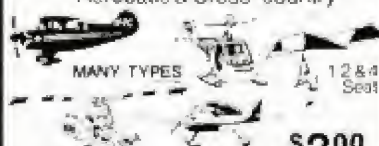
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96.6 percent; Honda Prelude, 96.1; Saab, 95.4; Volvo and VW Rabbit diesel, 92.3.

A Texas real estate agent grumbled, "The Seville's engineering is excellent, but for \$22,000 I expect a little more quality. The paint job is extremely poor, the fan-belt pulleys were misaligned, fuel gauge was incorrect, and the car needed a lot of minor adjustments."

In all, 15.5 percent of our owners mentioned fan-belt breakage. A North Carolina furniture dealer wrote, "All fan-belts broke at the same time as I was driving down the Interstate. I had the car towed to the nearest dealer, who happened to be a Chevrolet dealer. He charged me \$30 and advised me I would be reimbursed by my Cadillac dealer, but I was not."

Even so, Seville owners hold their dealers in high esteem, with 71.8 percent rating their service departments *good to excellent*. This figure stands considerably above the norm for both domestic and import agencies. Only Oldsmobile has topped Cadillac's figure in recent years, and then by a slim (four-point) margin.

A few owners complained about the cruise-control switch not energizing, and others noted rough transmission shifts. We should note that Cadillac instituted a recall having to do with shift linkage.



Lots of rear legroom plus a totally flat floor make rear passengers very comfortable.

Owners leave no doubt about the Seville's comfort. This is a four-passenger car, but each passenger has plenty of space, including rear legroom. "I'd rank riding comfort as excellent," observes a New York executive, "with ample roominess designed into both the front and rear compartment."

Styling, as mentioned at the beginning of this report, became the No. 1 persuader for most Seville owners' buying deci-

sions. And the most noticeable difference of this car—its bustle—stands out as perhaps its most controversial aspect.

"It's the car of the 1980s" maintains a Colorado bank director, "with great styling. It's a car with good trunk room, mostly because of the trunk height. I can stand an extra-large suitcase upright and then get the same-sized suitcase in lying flat."

As always, we asked respondents to list all the ways in which the manufacturer might improve his product. Here's a cross section of suggestions.

"I'd like to see a turbocharger offered, as on the Mercedes. The diesel really needs it. Also, the owner's manual ought to explain how to start the diesel if it runs out of fuel."—Texas truck-stop owner.

"Why isn't the fuel tank on gas-engined Seviles as large as on diesels? It's 23 gallons for diesels; only 20 for the regular V8."—Illinois self-employed.

"The fuel gauge on the diesel isn't too accurate. Cadillac should install the sort of gauge that compensates for fuel foaming."—Texas consulting engineer.

"The automatic door locks ought to be changed. When the car stops, only the driver's door unlocks. This is dangerous, because in an accident no one can open

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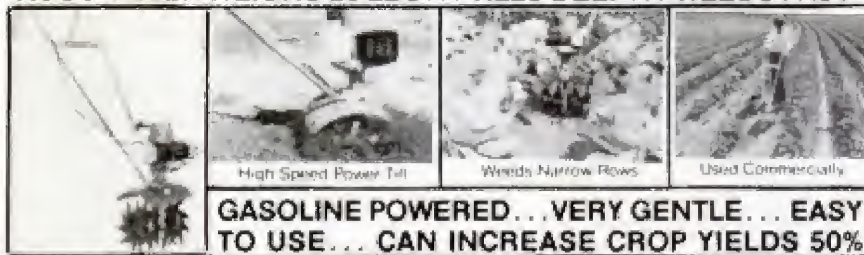
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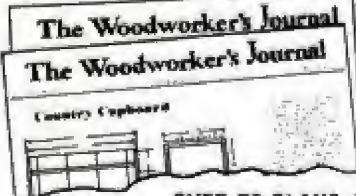


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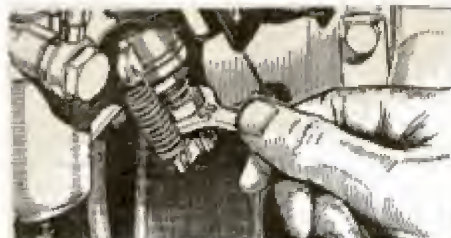
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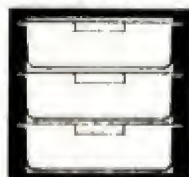
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(Continued on next page)



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(Continued from preceding page)

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(Continued from preceding page)

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